TECHNICAL APPENDICES A,B & C FOR DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR LOW FLOW AUGMENTATION AT

HODGES VILLAGE DAM

OXFORD, MASSACHUSETTS

FEBRUARY 1984

US Army Corps of Engineers
New England Division

APPENDIX A

WILDLIFE IMPACT ANALYSIS FOR A LOW FLOW

AUGMENTATION RESERVOIR SITE AT HODGES VILLAGE, MASSACHUSETTS

ADDENDUM TO APPENDIX A

Appendix A will be modified to include mitigation analysis (Sections 10,11) with the following features:

(1) Excavation of 10 acres of the fluctuating zone around the permanent pool (= stripped augmentation pool).

(2) Habitat Improvements including:

(a) Recalamation of the 9 acres of gravel pits.
(b) Habitat improvements to Marshes A, B and C.
(c) Modifications of the Reservoir Forestry Management Plan.

The islands and peninsulas would not be included in the proposed plan, for reasons discussed in Section III of the Draft Environment Impact Statement (EIS).

This change necessitates the addition of the following tables:

Section 10.3: pp. 64-65

The projected acreages for each cover type with the above described mitigation measures are shown in the attached Table 10.2. Removal of the 10 acres of islands and 15 acres of peninsulas would add 25 acres to the stripped permanent pool.

Section 10.4: pp. 65-68

The species evaluations should be read without reference to the islands and/or peninsulas.

Section 11: pp. 69-70

The changed acreages shown in Table 10.2 result in changes in the Average Annual Habitat Units gained by the mitigation plan without the islands and peninsulas. These changes are shown in the attached Table 11.2 See Section V-C of the Draft EIS for discussion.

TABLE 10.2: COVER TYPE AREA (ACRES), DISTRUBED AREA, AND SPECIAL MITIGATION AREA PREDICTIONS WITH THE PROJECT WITH MITIGATION (MINUS THE PROPOSED ISLANDS AND PENINSULAS)

Cover Type	Target Year					
	0	1	10	35	50	100
RIV	13	2	2	2	2	2
PEMM	18	7	7	7	7	7
PEMS	10	0	0	0	0	0
PSS						
Bog	17	8	8	8	8	8
Non-bog	45	3	6	6	6	6
PFO1	65	7	7	7	7	7
PFO4	23	23	23	23	23	23
UF/G	25	25	40	30	30	30
UFO1	384	361	329	296	271	271
UFO4	77	67	84	136	161	161
Disturbed	100	97	88	88	88	88
Freeboard	0	25	0	0	0	0
Stripped Augmentation Pool	0	7	7	7	7	7
Stripped Permanent Pool	0	113	113	113	113	113
Marshes A, B & C	0	35	35	35	35	35
TOTAL	794	794	794	794	794	794

TABLE 11.2: AVERAGE ANNUAL HABITAT UNITS OVER 100 YEARS WITHOUT THE PROPOSED ISLANDS AND PENINSULAS

EVALUATION SPECIES	WITHOUT PROJECT (A)	PROJECT WITHOUT MITIGATION (B)	NET CHANGE (B-A)	PROJECT WITH MITIGATION (C)	NET CHANGE (1) (C-A)
Red-Backed Vole	123	74	-49	145	+22
Mink	391	292	-99	286(2)	-105
Muskrat	22	16	-6	26	+4
Dusky Salamander	114	42	-72	38	-76
Wood Frog	257	191	-66	241	-16
Snapping Turtle	34	39	+5	62(3)	+28
Green Heron	128	57	-71	54	-74
Black Duck	60	22	-38	27	-33
Wood Duck	91	48	-43	67	-24
Broad-Winged Hawk	653	532	-121	541	-112
American Woodcock	179	145	-34	230	+51
Belted Kingfisher	36	104	+68	107(3)	+71
Downy Woodpecker	369	297	-72	355	-14
Yellow Warbler	40	23	-17	24	-16
Swamp Sparrow	119	54	-65	54	-65
TOTAL AAHU's	2616	1936	-680	2257	-359

(1) The values in this column differ from those in Table 11.1 because the AAHU's contribution of the islands and/or peninsulas have been subtracted for the following species: red-backed vole - 2; mink - 13; muskrat - 11; snapping turtle - 13; green heron - 23; black duck - 12; wood duck - 5; broad-winged hawk - 8; belted kingfisher - 10; yellow warbler - 7; swamp sparrow - 18.

(2) Removal of the peninsulas eliminates use of the 88 acre permanent pool by mink. The AAHU's in Table 11.1 were calculated using the permanent pool acreage (88) plus the 100 meter band (111 acres) around the permanent pool (= 199 acres). In addition, AAHU contribution by the permanent pool (82) was subtracted.

(3) These values have been modified from those in Table 11.1 because the removal of the islands and peninsulas resulted in an increase in pool acreage from 88 acres to 113 acres. Hence, 6 AAHU's were added to snapping turtle and 18 AAHU's to belted kingfisher.

WILDLIFE IMPACT ANALYSIS
for a
LOW FLOW AUGMENTATION
RESERVOIR SITE
at
HODGES VILLAGE, MASSACHUSETTS

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EXECUTIVE SUMMARY

INTRODUCTION

The Hodges Village Dam and Reservoir site in Oxford, Massachusetts, has been the subject of investigation as a possible water source for a proposed low flow augmentation project for the French River. The existing dam and reservoir system is a single purpose flood control project located on the French River and completed in 1959. Day-use recreation occurs in the surrounding area. Public hunting and fishing are encouraged. Portions of the area are managed by the Massachusetts Department of Fisheries, Wildlife, and Recreational Vehicles.

Currently the flood control system operates as a "dry bed" reservoir, that is, reservoir pool height is reduced to minimum levels as soon as practical after storm events. The proposed project would maintain a permanent pool of 6.5 feet (depth at dam). During spring, pool depth would be increased to between 10.0 and 10.5 feet and subsequently drawn down to augment French River flow during the summer. To accommodate the permanent and augmentation pools, approximately 180 acres of land would require clearing. Of the 180 acres, approximately 120 acres would be stripped of topsoil in order to avoid water quality degradation. Clearing, stripping, and inundation would impact wildlife communities at Hodges Village. A mitigation program would partially offset these impacts. Potential wildlife impacts and mitigation proposals form the subject matter of this report.

Habitat Evaluation Procedures developed by the U. S. Fish and Wildlife Service were utilized to evaluate baseline and future wildlife conditions. Three future scenarios were developed based on (1) future without the project, (2) future with the project without mitigation, and (3) future with the project with mitigation. The Habitat Evaluation Procedures analysis utilized fifteen evaluation species as indicators of impacts to a broad spectrum of wildlife. Based on measured parameters during the summer of 1983, habitat conditions were evaluated for each of the fifteen species. Future habitat conditions for each scenario were extrapolated from baseline conditions and assumptions related to vegetation dynamics (succession) and land use policy. Comparison of projected habitat conditions resulted in an evaluation of wildlife impacts stemming from the project both with and without mitigation.

EVALUATION SPECIES

Fifteen species were chosen from seventy four candidate evaluation species which were present or had a high probability of being present at Hodges Village. The species selection was done after inspecting a guild analysis which grouped the candidate species based upon similar resource utilization patterns. This aided in choosing species which would represent a broad spectrum of wildlife. The following species were chosen as evaluation species:

Red-Backed Vole	Wood Duck
Mink	Broad-Winged Hawk
Muskrat	American Woodcock
Dusky Salamander	Belted Kingfisher
Wood Frog	Downy Woodpecker
Snapping Turtle	Yellow Warbler
Green Heron	Swamp Sparrow
Black Duck	

This list included small and medium sized mammals, reptiles. amphibians, and birds. Birds were represented by a raptor, various waterfowl, song birds and other types. Vertebrate carnivores, invertebrate carnivores, omnivores, and herbivores were represented. One or more of the species in the list utilized resources for reproduction which were available in each of the tree, shrub, and herbaceous vegetated layers, in water, and in banks.

STUDY SITE

A study site was identified that included all areas upstream of Hodges Village Dam which were expected to be impacted by the project. Additional acreage of surrounding land was included in the study site because of biological linkages between the impact zone and contiguous areas. A total of 794 acres were evaluated. The floor of the French River valley upstream from Hodges Village Dam was observed to be relatively flat and in places the River had strong meandering characteristics. The valley floor was broad with ridges on either side forming the major relief in the study site. The majority of projected impact area was at elevations ranging from 469 to 474 feet. Ridges rose to over 500 feet. The dam invert elevation which formed the low water level for the French River was at an elevation of 465.5 feet.

The following ten cover types were identified and mapped:

palustrine deciduous forested wetlands;
palustrine needle-leaved evergreen forested wetlands:
palustrine scrub-shrub wetlands;
palustrine emergent wetlands
upland deciduous forest;
upland needle-leaved evergreen forest;
upland scrub-shrub;
upland forb/grassland
riverine;
disturbed.

A randomized sampling program was devised and salient parameters were sampled in each vegetated cover type. Over 40 different parameters were sampled. The habitat suitability of each cover type for each evaluation species was determined using Habitat Suitability Index models. In so doing, factors which most probably limit population densities were identified.

FUTURE CONDITIONS WITHOUT THE PROJECT

Habitat conditions were projected for certain target years based on the life of the project (as determined by the Corps) and periods of time over which various changes in habitat conditions were expected occur. Four target years were identified for conditions without the project. Target year 0 was represented by baseline conditions. Target year 1 was included primarily for purposes of comparison with other scenarios. The Corps anticipated changes in the upland forested cover types because of their forestry management program. These changes were estimated to reach conclusion within 50 years and accordingly a target year of 50 was included. A target year of 100 was used since the life of the project was determined by the Corps to be 100 years.

Two types of changes were anticipated. Cover type area ratios would vary over time and the habitat conditions within certain cover types would be altered. The areas of three cover types were expected to change. Upland forb/grassland areas would vary because of forest management and natural succession. Upland deciduous forest would decrease from 384 acres to 195 acres while upland needle-leaved evergreen forest would increase from 77 acres to 273 acres because of forest management. Conditions within certain cover types were expected to change as a result of natural succession and forest management, most important of which was a projected increase in Cattail. Over the 100 years, changes in conditions were predicted to alter populations of seven of the fifteen evaluation species. Habitat Units (a measure of the total quantity and quality of habitat) would decline for Red-Backed Vole, Wood Frog, American Woodcock, and Downy Woodpecker. Habitat Units would increase for Muskrat, Dusky Salamander, and Wood Duck.

FUTURE CONDITIONS WITH THE PROJECT WITHOUT MITIGATION

These conditions were defined by superimposing alterations in habitat conditions resulting from project construction and operation upon predicted conditions without the project. A 180 acre impact zone was identified, the majority of which would develop into an aquatic ecosystem at the expense of existing habitats. Project construction would clear this zone of vegetation. Approximately 120 acres of the zone would be stripped of topsoil. The zone was divided into five impact segments: (1) a freeboard region around the augmentation pool, (2) a stripped augmentation pool, (3) a cleared augmentation pool, (4) a stripped permanent pool, and (5) a cleared permanent pool. These impact segments also reflect project operation in that the augmentation pool area would be alternately inundated and exposed while the permanent pool area would be permanently inundated.

Potential inundation above the augmentation pool was evaluated. Elevations above the augmentation pool would probably be most susceptible to inundation when the augmentation pool was near capacity in June and July. Potential for inundation at these elevations was expected to be limited for two reasons. First, the Corps plans to install a computerized control structure at the dam with manual override. The computer would sense an increase in pool elevation and begin releasing water (unless flood danger exists in which case the dam would be operated manually). This would attenuate the rise in pool height. Second, the topography of the augmentation reservoir and its storage capacity would contain storm runoff without inundating large (relative to present operations) areas beyond the augmentation pool. Except in unusual storm events, pool elevation can be expected to be contained within the Freeboard region. Based on present operations, impoundment above the augmentation pool can be expected to be drawn down within several days.

Six target years were established, four of which (TY 0, TY 1, TY 50, and TY 100) were identical to the "without project" scenario. The freeboard region was expected to develop a shrub cover within 10 years and hence a target year 10 was used. The cleared (but not stripped) permanent and augmentation pool areas were expected to develop into marsh within 35 years and hence a target year of 35 was established.

Over the 100 years, changes in conditions were predicted to alter populations of all evaluation species. The quantity and/or quality of habitat for thirteen of the species was calculated to decrease. Habitat Units for Snapping Turtle and Belted Kingfisher were predicted to increase, primarily because these species were expected to take advantage of the reservoir as habitat. A general pattern for evaluation species was observed in that Habitat Units fell immediately after construction followed by a period of recovery. Recovery in most instances was not great enough to reach conditions predicted for the "without project" scenario.

FUTURE CONDITIONS WITH THE PROJECT WITH MITIGATION

A variety of actions which could potentially achieve partial mitigation for wildlife impacts were examined. These actions were evaluated for effectiveness and practicality and assembled into a recommended mitigation program. Alterations in habitat conditions as a result of mitigative actions were superimposed on predicted conditions with the project and the quantity and quality of resulting habitats computed.

The mitigation program was divided into three categories: recommendations related to (1) the stripped augmentation pool, (2) "in kind" replacement, and (3) habitat improvement. The stripped augmentation pool was identified as a high stress environment because it will be subject to both topsoil removal and alternate long term inundation followed by long term exposure. A large portion of this area could be deepened by excavation to the permanent pool level which would remove one of the conditions causing stress to organisms.

The major impact identified was the replacement of wetland by the permanent and augmentation pools. Consideration was given to various methods of replacing lost wetland. Creation of twenty five acres of islands and peninsulas within the augmentation and permanent pools was identified as the most feasible method. An approach was developed which was expected to create useful wetland habitat without adversely affecting augmentation pool storage capacity or water quality.

A number of actions were recommended to improve habitat conditions after project construction. Reclamation of 9 acres of gravel pits which were on Corps property was determined useful. Habitat conditions in cleared (but not stripped) areas of the augmentation and permanent pools could be enhanced by altering topography. The forestry management program could be fine tuned to partially compensate wildlife impacts.

The same target years as used in the "project without mitigation" scenario were utilized to compute future habitat quantity and quality for the evaluation species. Over the 100 years, changes in conditions were predicted to alter populations of all evaluation species. Habitat Units for ten of the species were expected to decline. Habitat Units for Mink, Muskrat, Snapping Turtle, American Woodcock, and Belted Kingfisher were expected to increase. A general pattern for evaluation species was observed in that Habitat Units fell immediately after construction followed by a period of recovery. Recovery was generally improved over the "without mitigation" scenario.

CONCLUSIONS

The three scenarios were compared by computing Average Annual Habitat Units (Habitat Units which were averaged and annualized over the life of the project). Without the project, the Average Annual Habitat Units (AAHU's) of all evaluation species totaled 2616. With the project without mitigation, the total was 1936, a decrease of 680 (26%). All but two of the species (Snapping Turtle and Belted Kingfisher) declined. With the project with mitigation, AAHU's totaled 2443, a decrease of 173 (7%) compared to the "without project" scenario. Five species, Red-Backed Vole, Muskrat, Snapping Turtle, American Woodcock, and Belted Kingfisher, were anticipated to increase while the other ten would decrease. The mitigation program recovered approximately 75% of the projected loss without mitigation. These results were expected to be applicable to a broad spectrum of wildlife which inhabit the project area.

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1. INTRODUCTION

1.1 SCOPE AND PURPOSE

The U.S. Army Corps of Engineers is studying the potential environmental effects of a proposed low flow augmentation project. As part of this study, Sanford Ecological Services was contracted to evaluate potential impacts to wildlife using a habitat based evaluation system known as H.E.P. (Habitat Evaluation Procedures, U.S. Fish and Wildlife Service, 1980-1981). The objectives of the study were to perform baseline, impact, and mitigation analyses of the habitat lost or altered by the proposed project. The study, discussed in this document, excluded consideration of aquatic organisms such as fish. Since the project will result in the creation of aquatic habitat, this report should be considered together with the Corps' aquatic analysis (found in the accompanying EIS) in order to understand the overall ecological implications of the project.

1.2 DESCRIPTION OF PROJECT

The proposed project is located at the Hodges Village Dam and Reservoir site in Oxford, Massachusetts. The existing dam and reservoir system is a single purpose flood control project located on the French River and completed in 1959. The flood control system has operated since its inception as a "dry bed" reservoir, that is, storm water runoff is stored only temporarily, water release is as rapid as possible, and reservoir pool height is reduced to minimum levels as soon as practical after storm events (U.S. Army Corps of Engineers, personal communication). The minimum pool level is controlled by the invert elevation at the dam. At this level a pool (marsh) of approximately 10 acres with a depth of 2 - 3 feet remains. This pool probably corresponds to a mill pond which existed prior to the construction of Hodges Village Dam.

Flood control is the prime function of the Hodges Village Dam and Reservoir system and will remain the prime function if the proposed project is implemented. Currently the project area is operated as a recreational area as long as such operation does not conflict with the prime purpose. The town of Oxford leases part of the project area for day-use recreation activities. Public hunting and fishing are encouraged. Portions of the area are managed by the Massachusetts Department of Fisheries, Wildlife, and Recreational Vehicles (U.S. Army Corps of Engineers, 1980). A master plan for recreation resources development (U.S. Army Corps of Engineers, 1980) and a forest management plan (U.S. Army Corps of Engineers, 1981) have been developed. It is anticipated that the project site will continue to operate as a flood control facility after implementation of the proposed project.

The low flow augmentation project would alter the reservoir from a "dry bed" system and create a permanent pool. On top of the permanent pool a seasonal augmentation pool would be created. The permanent pool stage would be 6.5 feet (depth at dam) and the augmentation stage would be between 10.0 and 10.5 feet. The rule curve for pool stage is presented in the Hydrology Appendix of the Feasibility Report. The project would result in either permanent or prolonged inundation of areas which presently receive short term inundation as a result of flood control operations. The reservoir would be cleared to a stage of 12 feet which is two feet above the augmentation pool elevation. In addition, land inundated by the pools east of the abandoned Boston and Albany Railroad (Webster Branch) would be stripped of top soil to prevent water quality degradation. It is expected that an average of 1.5 feet of topsoil over 103 acres would be removed (personal communication, U.S. Army Corps of Engineers). In order to prevent tree kill and to reduce maintenance and debris problems, a freeboard area around the augmentation pool would be cleared. The freeboard would extend 2 vertical feet above the augmentation pool.

1.3 APPROACH

A habitat based evaluation system, H.E.P. (U. S. Fish and Wildlife Service, 1981), was used in the analysis. A H.E.P. analysis uses evaluation species as indicators of habitat quality and assigns to each species a numerical rating from 0 to 1 (1 being optimum habitat) for each habitat (defined by a Cover Type) investigated. Each cover type can be evaluated based on measurable parameters. The resulting data is used to exercise Habitat Suitability Models with the result that a Habitat Suitability Index (HSI) is generated for each evaluation species. Future conditions are predicted for particular target years and HSI's are accordingly generated. This information is synthesized over the life of the project in the form of Average Annual Habitat Units (AAHU's) for each of three conditions: (1) future without the project, (2) future with the project without mitigation, and (3) future with the project with mitigation. Comparison of these projections results in an evaluation of the overall impact to wildlife.

A H.E.P. analysis began with the establishment of a H.E.P. team. The team was composed of representatives from the U. S. Army Corps of Engineers, the U. S. Fish and Wildlife Service, the Massachusetts Department of Fisheries, Wildlife, and Recreational Vehicles, and Sanford Ecological Services. Sanford Ecological Services contracted the services of Dr. William Mautz (Certified Wildlife Biologist, Wildlife Professor, University of New Hampshire) and Mr. Trevor Lloyd-Evans (Ornithologist, Manomet Bird Observatory, Manomet, Massachusetts) to act as specialized consultants during the course of the study. With the review and participation of the H.E.P. team, the steps followed were:

1. Develop a candidate evaluation species list;
2. Perform a guild analysis;
3. Choose evaluation species;

4. Map cover types and determine cover type areas;
5. Design a field data collection program;
6. Conduct field sampling;
7. Calculate baseline HSI's;
8. Select future target years;
9. Predict future conditions for target years;
10. Develop mitigation program;
11. Calculate future HSI's; and
12. Calculate Average Annual Habitat Units.

2. CANDIDATE EVALUATION SPECIES

2.1 CANDIDATE EVALUATION SPECIES CRITERIA

A H.E.P. analysis is directly applicable to the evaluation species chosen. The impacts to these evaluation species can be extrapolated to large segments of the wildlife community if the evaluation species are carefully chosen such that they can represent ecological groups or guilds. A guild is a grouping of species based upon similar resource utilization patterns. In addition to choosing species which can represent guilds, economically important species, which may or may not be good guild representatives, are included in the analysis because of their special importance.

A preliminary species list was prepared based upon the geographical location of the Hodges Village Reservoir and cover types known to be present on site. The list was derived from various literature sources, the Audubon Society's breeding bird census data from the area, and best professional judgement. The H.E.P. team and consulting wildlife specialists visited the site on 12 May, 1983 and evaluated existing cover types for the presence of wildlife. Evaluations included the confirmation of species presence based upon observations of the species, its signs, or its call (see Tables 2-1 and 2-2). In addition, species which have an extremely high probability of being present were identified using best professional judgement. This step was necessary since time constraints prevented the accumulation of seasonal census data. Cover types which will be directly impacted by the permanent and augmentation pools received greatest emphasis in the evaluation. Using the preliminary species list and observations made during the inspection, the H.E.P. team developed a candidate species list (see Section 2.2). Candidate species are those species which received consideration as evaluation species. To obtain candidate status, a species needed to (1) be a potentially useful indicator of wildlife impacts or economically important, (2) be confirmed as present or have an extremely high probability of being present; and (3) be a typical member of the wildlife community associated with the existing cover types. Typical is meant to imply that the species can be expected to consistently be a member of the community and not simply a transient or occasional member.

2.2 CANDIDATE EVALUATION SPECIES LIST

The following table lists species of mammals, amphibians, reptiles, and birds which were either confirmed present of have a high probability of being present on site and which could potentially meet the criteria outlined in Section 2.1.

TABLE 2-1: CANDIDATE EVALUATION SPECIES.

COMMON NAME	SCIENTIFIC NAME
Mammals	
Red-Backed Vole*	Clethrionomys gapperi
Deer Mouse	Peromyscus maniculatus
White-Footed Mouse	Peromyscus leucopus
Masked Shrew	Sorex cinereus
Short-tailed Shrew	Blarina brevicauda
Eastern Chipmunk	Tamias striatus
Red Squirrel	Tamiasciurus hudsonicus
Gray Squirrel*	Sciurus carolinensis
Eastern Cottontail	Sylvilagus floridanus
White-Tailed Deer*	Odocoileus virginianus
Long-Tailed Weasel	Mustela frenata
Mink*	Mustela vison
Red Fox*	Vulpes vulpes
River Otter	Lutra canadensis
Raccoon	Procyon lotor
Muskrat*	Ondatra zibethicus
Beaver*	Castor canadensis
Amphibians & Reptiles	
Spotted Salamander	Ambystoma maculatum
Dusky Salamander	Desmognathus fuscus
Eastern Newt*	Notophthalmus viridescens
Red-Backed Salamander	Plethodon cinereus
American Toad*	Bufo americanus
Spring Peeper	Hyla crucifer
Gray Treefrog	Hyla versicolor
Bullfrog*	Rana catesbeiana
Green Frog	Rana clamitans
Pickerel Frog	Rana palustris
Northern Leopard Frog	Rana pipiens
Wood Frog*	Rana sylvatica
Snapping Turtle	Chelydra serpentina
Spotted Turtle	Clemmys guttata
Eastern Box Turtle	Terrapene carolina
Racer	Coluber constrictor
Milk Snake	Lampropeltis triangulum
Water Snake	Nerodia sipedon
Common Garter Snake*	Thamnophis sirtalis
Birds	
Great Blue Heron*	Ardea herodias
Green Heron*	Butorides striatus
Mallard*	Anas platyrhynchos
Black Duck	Anas rubripes
Wood Duck	Aix sponsa
Red-Tailed Hawk*	Buteo jamaicensis
Broad-Winged Hawk*	Buteo platypterus
Killdeer*	Charadrius vociferus
American Woodcock*	Philohela minor
Spotted Sandpiper *	Actitis macularia

TABLE 2-1: CANDIDATE EVALUATION SPECIES (Continued).

COMMON NAME	SCIENTIFIC NAME
Birds	
Great Horned Owl	Bubo virginianus
Belted Kingfisher*	Megaceryle alcyon
Common Flicker*	Colaptes auratus
Downy Woodpecker*	Picoides pubescens
Eastern Kingbird*	Tyrannus tyrannus
Least Flycatcher	Empidonax minimus
Eastern Wood Pewee	Contopus virens
Tree Swallow*	Iridoprocne bicolor
Barn Swallow*	Hirundo rustica
Blue Jay*	Cyanocitta cristata
Black-capped Chickadee*	Parus atricapillus
Gray Catbird	Dumetella carolinensis
American Robin*	Turdus migratorius
Wood Thrush	Hylocichla mustelina
Veery*	Catharus fuscescens
Red-Eyed Vireo	Vireo olivaceus
Black-and-White Warbler*	Mniotilta varia
Blue-Winged Warbler*	Vermivora pinus
Yellow Warbler*	Dendroica petechia
Ovenbird*	Seiurus aurocapillus
Common Yellowthroat*	Geothlypis trichas
Red-Winged Blackbird*	Agelaius phoeniceus
Northern Oriole*	Icterus galbula
Common Grackle*	Quiscalus quiscula
Rufous-sided Towhee*	Pipilo erythrophthalmus
Chipping Sparrow*	Spizella passerina
Swamp Sparrow*	Melospiza georgiana
Song Sparrow*	Melospiza melodia

* Species confirmed or reported to be present on site.

2.3 ADDITIONAL SPECIES OBSERVED

In addition to species noted as confirmed in Table 2-1, other species were observed during the course of the study which were not considered as having candidate status. Table 2-2 lists these non-candidate species whose presence were confirmed.

TABLE 2-2: OTHER SPECIES CONFIRMED AS PRESENT.

COMMON NAME	SCIENTIFIC NAME
Canada Goose	Branta canadensis
Turkey Vulture	Cathartes aura
Ring-Phasianus Pheasant	Phasianus colchicus
Rock Dove	Columba livia
Mourning Dove	Zenaidura macroura
Common Crow	Corvus brachyrhynchos
White-Breasted Nuthatch	Sitta carolinensis
Brown Creeper	Certhia familiaris
Brown Thrasher	Toxostoma rufum
Blue-Gray Gnatcatcher	Polioptila caerulea
Golden-crowned Kinglet	Regulus satrapa
Starling	Sturnus vulgaris
Yellow-rumped Warbler	Dendroica coronata
Black-Thr. Green Warbler	Dendroica virens
Prairie Warbler	Dendroica discolor
Brown-headed Cowbird	Molothrus ater
Purple Finch	Carpodacus purpureus
House Finch	Carpodacus mexicanus
American Goldfinch	Spinus tristis
Field Sparrow	Spizella pusilla

3. GUILD ANALYSIS

3.1 APPROACH

Aside from economically important species, evaluation species were chosen which could be used to indicate potential impacts to a broad segment of the wildlife community. In order to insure that evaluation species would represent such a spectrum of wildlife, a guild analysis was performed prior to choosing the evaluation species. The objective of the guild analysis was to classify wildlife into ecologically related groups based upon similar resource utilization patterns. Obviously the criteria of classification determined the ultimate groupings. Such criteria needed to be broad enough so as to be practical (i.e. the species needed to be placed in groups of reasonable size). Also it was necessary to establish criteria which would reflect resources lost or altered on the site by the project or future management practices. Projections indicated that the project would clear all layers of vegetation in the impact area. Some portions of the land would also be stripped of top soil. Hence guild descriptors which divided the resources into a vegetated layer and a surface layer were critical. In addition the ratio of land occupied by different cover types would change and therefore guilds were erected for each cover type. Projected forestry management practices would alter the density of snags and the nature of the understory. Hence the vegetated layers were subdivided into tree, shrub, and herbaceous layers. The tree layer was divided into live vegetation and dead wood. Species which utilized the herbaceous layer and/or the ground surface and/or water were classified together. The inclusion of water may at first appear as an anomaly. However separate cover types were established for aquatic systems so that ecologically unrelated species were not lumped together. Many of the wetland cover types are seasonally flooded and upon the receding of flood waters, pools are left in small (10 or 20 feet in diameter) topographic depressions. These pools are potential breeding and foraging areas for many species which also utilize adjacent non-flooded areas as well. It was with this in mind that a guild descriptor of "Herbaceous Layer, Surface, and/or Water" was created. A subsurface category was also identified which was subdivided into "Flat Ground" (species which burrow near the surface) and "Bank" (species which excavate dens or nest in banks).

Two types of guilds were established; reproductive guilds and feeding guilds. Reproductive guilds grouped species by the location of their reproductive activities using the descriptors discussed above. Feeding guilds grouped species by the location of their foraging activities and by trophic level.

3.2 GUILDS

After establishing the guild criteria above, the natural histories of all candidate species were reviewed (see the Reference Section for a listing of literature used for this review). Because of the mobility of wildlife and breadth of individual niches, grouping wildlife in guilds must to some extent be based upon arbitrary decisions. It should be noted that different biologists would group species slightly differently based upon their own niche concepts. The guilds in this report were reviewed by competent professional biologists and are believed to fairly represent the wildlife in question in the context of Hodges Village. More importantly, they serve the original purpose of grouping species by resource utilization and in a way which allows projected impacts to be evaluated for a broad spectrum of wildlife.

Guild tables for all candidate species and for each cover type are presented in Appendix A. Summary guild tables for candidate species are presented in Tables 3-1 and 3-2.

TABLE 3-1:SUMMARY OF REPRODUCTIVE GUILDS AT HODGES VILLAGE.

LOCATIONAL DESCRIPTOR	*REPRODUCTIVE GUILD*
Tree Layer	
Live Vegetation	Gray Squirrel, Red Squirrel, Wood Duck, Tree Swallow, Eastern Kingbird, Least Flycatcher, Eastern Wood Pewee, Blue Jay, American Robin, Wood Thrush, Chipping Sparrow, Red-Eyed Vireo, Yellow Warbler, Northern Oriole, Common Grackle, Green Heron, Broad-Winged Hawk, Red-Tailed Hawk, Great Horned Owl
Dead Wood	Tree Swallow, Common Flicker, Downy Woodpecker, Black-capped Chickadee
Shrub Layer	Gray Catbird, Blue Jay, American Robin, Wood Thrush, Veery, Yellow Warbler, Common Yellowthroat, Rufous-Sided Towhee, Song Sparrow, Red-Winged Blackbird, Common Grackle, Green Heron, Swamp Sparrow
Herbaceous Layer, Surface, and/or Water	Red-Backed Vole, Deer Mouse, White-Footed Mouse, Masked Shrew, Short-Tailed Shrew, Long-Tailed Weasel, Raccoon, Beaver, Eastern Cottontail, White-Tailed Deer, Muskrat, Eastern Newt, Dusky Salamander, Red-Backed Salamander, Spring Peeper, Gray Treefrog, Green Frog, Pickerel Frog, Northern Leopard Frog, Wood Frog, Bullfrog, American Toad, Spotted Turtle, Eastern Box Turtle, Snapping Turtle, Milk Snake, Racer, Common Garter Snake, Water Snake, Black Duck, Mallard, Blue-Winged Warbler, Black-and-White Warbler, Ovenbird, American Woodcock, Veery, Common Yellowthroat, Rufous-Sided Towhee, Song Sparrow, Killdeer, Red-Winged Blackbird, Common Grackle,Swamp Sparrow
Subsurface	
Flat Ground	Eastern Chipmunk, Long-Tailed Weasel, Red Fox
Bank	Mink, River Otter, Muskrat, Beaver, Spotted Sandpiper, Belted Kingfisher

TABLE 3-2: SUMMARY OF FEEDING GUILDS AT HODGES VILLAGE.

DESCRIPTOR	FEEDING GUILD
Vegetated Layers	
Vertebrate Carnivore	None
Invertebrate Carnivore	Gray Treefrog, Tree Swallow, Barn Swallow, Downy Woodpecker, Eastern Kingbird, Least Flycatcher, Eastern Wood Pewee, Red-Eyed Vireo, Black-and-White Warbler, Yellow Warbler
Omnivore	Black-Capped Chickadee, Blue Jay, American Robin, Northern Oriole, Song Sparrow, Swamp Sparrow
Herbivore	Gray Squirrel, Red Squirrel
Surface and/or Water	
Vertebrate Carnivore	Long-Tailed Weasel, Mink, Red Fox, Racer, Milk Snake, Common Garter Snake, Water Snake, Red-Tailed Hawk, Broad-Winged Hawk, Great Horned Owl, Spotted Sandpiper, Green Heron, Great Blue Heron, Belted Kingfisher
Invertebrate Carnivore	Masked Shrew, Short-Tailed Shrew, Spotted Salamander, Dusky Salamander, Eastern Newt, Red-Backed Salamander, American Toad, Spring Peeper, Green Frog, Pickerel Frog, Northern Leopard frog, Wood Frog, Bullfrog, Spotted Turtle, Eastern Box Turtle, Common Garter Snake, Common Flicker, Blue-Winged Warbler, Eastern Wood Pewee, Ovenbird, Common Yellowthroat, Killdeer, American Woodcock, Tree Swallow, Barn Swallow, Eastern Kingbird, Spotted Sandpiper, Black Duck
Omnivore	Deer Mouse, White-Footed Mouse, Eastern Chipmunk Raccoon, Snapping Turtle, Song Sparrow, Wood Duck, Gray Catbird, American Robin, Wood Thrush, Veery, Rufous-Sided Towhee, Red-Winged Blackbird, Common Grackle, Swamp Sparrow, Chipping Sparrow
Herbivore	Red-Backed Vole, Eastern Cottontail, White-Tailed Deer, Muskrat, Beaver, Mallard

4. EVALUATION SPECIES SELECTION

4.1 APPROACH

As previously mentioned, evaluation species fall into two categories; (1) they are representative of guilds and/or (2) they are economically important. Three species were initially identified by the Massachusetts Department of Fisheries, Wildlife, and Recreational Vehicles as economically important. These species were Muskrat, Black Duck, and Wood Duck. Muskrat was present on the site in moderately low abundance and is a reasonable ecological choice. Black Duck was not observed on the site. There is a high probability of its presence although in low density. However, it is ecologically similar in many respects to Mallard which was observed in moderate density. Wood Duck also was not observed but has a high probability of being present in low density. These two species offered a means of evaluating breeding and brooding habitat for ducks in general.

Other species were selected based upon their ecological position within the community. Since results of a H.E.P. analysis are directly applicable to the evaluation species and only indirectly applicable to other wildlife, the greater the number of evaluation species, the greater will be the accuracy of the analysis. However it is not practical to obtain detailed information on every species present. Furthermore, there is a diminishing return law involved. The first few evaluation species provide great insight into potential wildlife impacts. As more species are evaluated, the overall nature of project impacts remains unaltered and details become lucid. The exact number of evaluation species which should be used is therefore debatable. The Army Corps of Engineers had originally discussed using between 5 and 10 species at Hodges Village. A majority of the H.E.P. team felt that this number was too few. After examining the candidate evaluation species list and guild analysis, a majority of the H.E.P. team agreed to 15 species.

Evaluation species were chosen based upon a number of considerations including the following: (1)The species list should be biased toward organisms which make major utilization of cover types that will be impacted most by the project. Wetland cover types, specifically Red Maple Swamps, Shrub Swamps, Herbaceous Wetlands, and the French River, are projected to receive the greatest disturbance. (2)The species should be sensitive to the types of expected impacts. Since the project will significantly alter habitat characteristics, most of the candidate species would respond. (3)A broad representation of major taxa should be included in the list. (4)As many guilds as possible should be represented. And (5)HSI models should be available for the species.

4.2 EVALUATION SPECIES LIST

The following 15 species were chosen as evaluation species:

Red-Backed Vole	Wood Duck
Mink	Broad-Winged Hawk
Muskrat	American Woodcock
Dusky Salamander	Belted Kingfisher
Wood Frog	Downy Woodpecker
Snapping Turtle	Yellow Warbler
Green Heron	Swamp Sparrow
Black Duck	

This list includes small and medium sized mammals, reptiles, amphibians, and birds. Birds are represented by a raptor, various waterfowl, song birds and other types. Vertebrate carnivores, invertebrate carnivores, omnivores, and herbivores are represented. One or more of the species in the list utilize resources available in each of the vegetated layers, water, and banks for reproduction. The guild classifications for these species are included in Appendix A by cover type. Tables 4.1 and 4.2 illustrate summary guild matrices.

TABLE 4-1: SUMMARY OF REPRODUCTIVE GUILDS FOR EVALUATION SPECIES.

DESCRIPTOR	REPRODUCTIVE GUILD
Tree Layer	
Live Vegetation	Green Heron, Wood Duck, Broad-Winged Hawk, Yellow Warbler
Dead Wood	Downy Woodpecker
Shrub Layer	Green Heron, Yellow Warbler, Swamp Sparrow
Herbaceous Layer, Surface, and/or Water	Red-Backed Vole, Muskrat, Dusky Salamander, Wood Frog, Snapping Turtle, Black Duck, American Woodcock, Swamp Sparrow
Subsurface	
Flat Ground	None
Bank	Mink, Muskrat, Belted Kingfisher

TABLE 4-2: SUMMARY OF FEEDING GUILDS FOR EVALUATION SPECIES.

DESCRIPTOR	FEEDING GUILD
Vegetated Layers	
Vertebrate Carnivore	None
Invertebrate Carnivore	Downy Woodpecker, Yellow Warbler
Omnivore	Swamp Sparrow
Herbivore	None
Surface and/or Water	
Vertebrate Carnivore	Mink, Green Heron, Broad-Winged Hawk, Belted Kingfisher
Invertebrate Carnivore	Dusky Salamander, Wood Frog, Black Duck, American Woodcock
Omnivore	Snapping Turtle, Wood Duck, Swamp Sparrow
Herbivore	Red-Backed Vole, Muskrat

Although the entire H.E.P. team approved the above species list, the U.S. Fish and Wildlife Service indicated that an additional 5 species should be included as evaluation species. These species were Bullfrog, Eastern Newt, Veery, Red Squirrel, and Virginia Rail. The following presents rationale for not including them in the list.

Bullfrog utilizes aquatic habitats and prefers ponds, lakes, and slow-moving streams with sufficient vegetation to provide cover . Its normal diet consists of insects, crayfish, other frogs, and minnows. During reproduction, egg masses are attached to submerged vegetation. Tadpoles may take almost 2 years to transform (Behler and King, 1979). Critical aspects of Bullfrog habitat therefore include the presence of permanent water which is at least slow moving and adequate vegetation for cover and egg attachment sites. These same resources are critical to a number of the evaluation species utilized in the analysis. The presence of permanent water which is at least slow moving is critical to Snapping Turtle. Green Heron is adversely affected by a water regime which is less than permanent and by water currents that are more than slow moving. Many of the evaluation species are adversely affected by a lack of emergent or aquatic vegetation including Muskrat, Wood Duck, and Black Duck. Wood Frog is included as an evaluation species and while its habitat preferences are not identical to Bullfrog, Wood Frog exhibits similar life stages and represents the same major taxonomic group.

Eastern Newt inhabits ponds and lakes with dense submerged vegetation, streams, ditches, swamps, and damp woodlands. It forages in shallow water for invertebrates, and eggs. Eggs are laid on submerged vegetation (Behler and King, 1979). Critical aspects of the Eastern Newt's habitat therefore include the presence of wetlands and associated aquatic habitats. Aquatic vegetation is needed to provide adequate cover and reproductive requirements. Thirteen of the evaluation species are entirely or heavily dependent upon wetland habitats. Aquatic vegetation is critical to snapping turtle. Dusky Salamander (an evaluation species) is ecologically similar in many respects including its food requirements and represents the same major taxon as the Eastern Newt.

Veery inhabits moist woodlands with an understory of low trees and shrubs. Its diet is approximately 60% insects and 40% fruits and foraging occurs on the forest floor. Nesting generally occurs on or near the ground in dense vegetative cover (U.S. Fish and Wildlife, undated HSI model). Critical habitat parameters are (1) % of the cover type flooded, (2) soil moisture regime, (3) % deciduous shrub crown cover, (4) average height of deciduous shrubs, (5) % herbaceous canopy cover, and (6) average height of herbaceous canopy. Both Yellow Warbler and Swamp Sparrow respond to vegetative cover and height. Although these two evaluation species differ from Veery in their detailed response patterns, the general response patterns are very similar. Low values of cover and height limit all three species. Also cover type utilization overlaps among the three species. The soil moisture regime requirements of Veery are similar to American Woodcock.

Red Squirrel inhabits coniferous and mixed deciduous-coniferous forests. It is herbivorous and conifer seeds form a major component of its diet. Tree cavities are preferred for nest sites although tree nests located in branches are more common because of low cavity densities in coniferous forests (U.S. Fish and Wildlife Service, HSI Model, 1981). Although Red Squirrel may be present at Hodges Village, none were seen during the period of study. Only a low density of Gray Squirrels were observed. The U.S. Fish and Wildlife HSI model is applicable to evergreen forests, however only approximately 8 acres (4%) of the projected impact area will consist of this cover type. Red Squirrel is not considered a good evaluation species since it does not presently occur commonly at Hodges Village and it would only be indicative of a small portion of the impact area.

Virginia Rail was proposed as a surrogate for the American Bittern. American Bittern inhabits marshes, meadows, swamps and bogs with tall vegetation such as cattails and bulrushes. It is a wading bird which consumes frogs, reptiles, crustaceans, insects, small fish, small mammals, and spiders. Nest sites are usually well-hidden in tall vegetation such as reeds and cattails (DeGraff et al., undated). DeGraff et al. states: "So shy, bitterns are seldom seen. They are known to abandon a marsh at the slightest disturbance." The marsh habitats in the impact area have very little tall herbaceous vegetation. In July, the average measured height of herbaceous vegetation in this habitat was under 17 inches, although later in the season height was estimated at 3 - 4 feet. Also the area is heavily used by off road vehicles including trail bikes. The presence of a well established population of American Bittern is questionable at best. Virginia Rail, acting as a surrogate, was suggested as the evaluation species. Inspection of the Virginia Rail HSI model shows strong similarities in suitability index parameters with Swamp Sparrow (an evaluation species). Both species models utilize % herbaceous canopy cover and average height of herbaceous vegetation. Both species models demonstrate similar suitability index responses to these parameters. Finally, it should be noted that Green Heron, a wading bird with similar food preferences to the American Bittern, is included as an evaluation species.

In summary, the five additional species suggested by the U.S. Fish and Wildlife Service appear to either be redundant to the 15 evaluation species, or in the case of Red Squirrel not a good indicator of expected impacts.

5. STUDY SITE

5.1 GENERAL LANDSCAPE FEATURES

The Hodges Village project site is located on the French River which drains from the north to the south (see Figure 5.1, page 22). The dam formed the southern boundary of the study site. The study site included all areas upstream of the dam which were expected to be impacted by the project. In addition to impact areas, the study site included significant acreage of surrounding land so that a total of 794 acres were evaluated. Extending the study site beyond impact areas was required because of strong ecological interdependency between the impact areas and surrounding terrain. For example, several of the evaluation species were multi-cover type users. Thier presence and abundance in the impact areas were at least partially dependent upon the presence of suitable habitat outside of the impact areas.

An abandoned railroad bed, used as a dirt road, ran approximately parallel with the French River on its west side. Several other dirt roads were present on both sides of the River which gave excellent access to the study site. Operational or abandoned gravel pits were conspicuous landscape features.

The floor of the French River valley was observed to be relatively flat and in places the River had strong meandering characteristics. The valley floor was broad with ridges on either side forming the major relief in the study site. The majority of projected impact area was at elevations ranging from 469 to 474 feet. Ridges rose to over 500 feet. The dam invert elevation which formed the low water level for the French River was at an elevation of 465.5 feet. Because of the flat nature of the valley floor, past storm water retention inundated large areas of wetland with relatively small increases in pool elevation. The storage capacity/pool elevation ratio has been demonstrated to increase very rapidly with increasing pool height. Despite the relatively flat nature of the valley floor, the wetlands adjacent to the French River were roughly shaped as an hour glass with a constriction in the middle. The permanent pool has been projected to take a similar shape. This shape indicated the presence of two sub-basins; the upper basin was at an elevation of approximately 471 feet and the lower at 469 feet.

5.2 COVER TYPE DESCRIPTIONS

The vegetation in the study site was classified into uplands and wetlands. Wetland cover types were named following the classification system presented in "Classification of Wetlands and Deepwater Habitats of the United States" (U.S. Fish and Wildlife Service, 1979). Upland cover type names parallel the wetland classification. Wetland cover types represented on the site were (1) palustrine deciduous forested wetlands (PFO1), (2) palustrine needle-leaved evergreen forested wetlands (PFO4), (3)palustrine scrub-shrub wetlands (PSS), and palustrine emergent wetlands (PEM). Upland cover types represented on the site were

(1) upland deciduous forest (UFO1), (2) upland needle-leaved evergreen forest (UFO4), (3)upland scrub-shrub (USS), and (4)upland forb/grassland (UF/G). In addition, the French River was classified as riverine (RIV) and gravel pits, dirt roads, etc. were classified as disturbed.

5.2.1 PALUSTRINE DECIDUOUS FORESTED WETLANDS (PFO1): These wetlands were dominated by Red Maple (Acer rubrum) in the overstory. Tree canopy closure was often above 90%; however, scattered areas with tree fall commonly reduced canopy closure to between 60 and 80%. A shrub understory of Red Maple, Arrowwood (Viburnum dentatum), Withe-Rod (Viburnum cassinoides), Swamp Dogwood (Cornus amomum), Swamp Azalea (Rhododendron viscosum), and Highbush Blueberry (Vaccinium corymbosum) was present. The herbaceous layer included Tussock Sedge (Carex stricta), Skunk Cabbage (Symplocarpus foetidus), Royal Fern (Osmunda regalis), Cinnamon Fern (Osmunda cinnamomea), Sensitive Fern (Onoclea sensibilis), Marsh Fern (Thelypteris palustris), and Sphagnum (Sphagnum sp.). Shrub canopy closure was approximately 30% and average shrub height was about 30 inches. Soils were generally near or at saturation and of medium texture with a high organic component. Small pools, often left by tree fall which uprooted the root system, were scattered throughout the cover type.

5.2.2 PALUSTRINE NEEDLE-LEAVED EVERGREEN FORESTED WETLANDS (PFO4): This cover type was essentially restricted to one area of the study site and dominated by Atlantic White Cedar (Chamaecyparis thyoides). Red Maple was present in varying densities. Hemlock (Tsuga canadensis) occurred, especially in slightly drier sites such as around the perimeter of the wetland. Hemlock is an upland species which commonly has a local distribution pattern extending into wetlands. The tree layer was dense; canopy closure exceeded 90%; basal area (total square feet of cross sectional area of trees at breast height per acre) was on the average highest of all cover types; and the tree diameter at breast height was small (around 6 inches). The shrub and herbaceous layers were depressed by the dense tree canopy. Shrub cover was generally less than 20% and species composition was similar to the Red Maple dominated areas. The herbaceous cover was high but only because of Sphagnum. Marsh and Sensitive ferns were observed. Carex and several hydrophytic grasses were present. Pitcher Plant (Sarracenia purpurea) was scattered throughout the cover type.

5.2.3 PALUSTRINE SCRUB-SHRUB (PSS): The shrub wetland vegetation was more variable than other cover types and included bog and non-bog systems. Physiognomy was similar in that vegetation was dominated by the shrub layer and a tree layer was essentially absent. The substrate ranged from sphagnum in bogs to a medium textured mineral soil with high organic content elsewhere. Certain habitat characteristics, such as shrub cover, were similar throughout the cover type. The similarity of these resources resulted in almost identical suitability indices for a number of evaluation species (primarily birds) when bog and non-bog areas were compared. The suitability indices of other evaluation species, such as Red-Backed Vole, differed noticeably. These results indicated that, depending upon the evaluation species, wildlife may respond to this cover type as being homogeneous or nonhomogeneous. It was decided that the cover type would not be split into subunits which were each depicted in tables, but rather that HSI's for each evaluation species would be weighted by the ratio of bog to non-bog acreage. This in effect allowed bog and non-bog areas to be treated separately without raising each to the status of a separate cover type.

Bog areas were dominated by Leatherleaf (Chamaedaphne calyculata). The previous season's leaves were present indicating that populations of Leatherleaf at Hodges Village were evergreen. Swamp Laurel (Kalmia polifolia), Sheep Laurel (K. angustifolia), Swamp Azalea, and Highbush Blueberry were scattered in the bogs. Cranberries (Vaccinium macrocarpum and V. oxycoccus) were common. Occasional White Pine (Pinus strobus), Tamarack (Larix laricina), and Black Spruce (Picea mariana) were also observed. The herbaceous layer was composed primarily of Sphagnum. Sundew (Drosera sp.) was also present.

Non-bog areas varied in their vegetational composition. The most common stands were dominated by Swamp Dogwood and Buttonbush (Cephalanthus occidentalis). Willow (Salix sp.) was abundant in a number of stands as were Arrowwood, Speckled Alder (Alnus incana), and Meadowsweet (Spiraea latifolia). The herbaceous layer was dominated by Tussock Sedge and ferns. Several stands were classified as shrub wetlands because of extensive toppled Red Maple trees. These stands had a composition similar to the understory of Red Maple Swamps described above.

5.2.4 PALUSTRINE EMERGENT WETLANDS (PEM): This cover type includes both herbaceous wetlands which are seasonally flooded and those which are permanently flooded. The two types are both vegetationally distinct and markedly different in their water regimes. Consistent differences in evaluation species HSI's were noted. Therefore two subcategories of this cover type were established, palustrine emergent sedge (PEMS) and palustrine emergent marsh (PEMM).

Palustrine emergent sedge stands were dominated by Tussock Sedge. Herbaceous cover averaged 68%. The tussocks formed a very uniform pattern with leaves spreading outward. Muck formed the substrate between tussocks and was often covered with filamentous algae. Occasional shrubs (Swamp Dogwood and Buttonbush) were scattered within the cover type.

Palustrine emergent marsh stands were permanently flooded. Submerged aquatic vegetation (various pond weeds, Elodea sp. and Myriophyllum sp.) were abundant. Floating leaved plants (Nuphar sp.) covered large areas. Emergent vegetation included Rushes (Juncus spp.), Spikerush (Eleocharis sp.), Wool-Grass (Scirpus cyperinus), Phragmites (Phragmites communis), and Cattail (Typha latifolia). Cattail and Phragmites were scarce and present in small patches along the perimeter of stands.

5.2.5 UPLAND DECIDUOUS FOREST (UFO1): This cover type was dominated by a mixed oak overstory (Quercus alba, Q. velutina, and Q. borealis). Varying amounts of White Pine were present.

Tree canopy cover generally exceeded 90%; basal area was high; and average diameter at breast height was only approximately 8 inches. The shrub layer contained Black Huckleberry (Gaylussacia baccata), Sheep Laurel, and Low-Bush Blueberry (Vaccinium angustifolium). Shrub cover averaged over 50%; and shrub height averaged approximately 20 inches. The herbaceous layer averaged 47% cover and 6 inches in height. Bracken Fern (Pteridium aquilinum) and Wintergreen (Chimaphila maculata) were common.

5.2.6 UPLAND NEEDLE-LEAVED EVERGREEN FOREST (UF04): This cover type was dominated largely by White Pine. Other pines (Pitch Pine, P. rigida, and Scots Pine, P. sylvestris) and Hemlock were observed within the cover type. Also oaks were present in varying abundance. Tree canopy closure was above 90%; basal area was high; and trees were often greater than 24 inches in diameter at breast height. Tree height was greatest in this cover type averaging over 60 feet. Shrubs included Arrowwood, Lowbush Blueberry, and Black Huckleberry. Average shrub cover was 40%. Herbaceous cover was similar to the mixed oak stands discussed above.

5.2.7 UPLAND SCRUB-SHRUB (USS): Scrub-shrub vegetation was present in areas which had been disturbed by clearing, herbicide spraying, and top soil removal. Sweet Fern (Comptonia peregrina), Sheep Laurel, and Meadowsweet were most common. This cover type forms a transitional stage over time and evidence of succession was observed. Young saplings of various tree species including Quacking Aspen (Populus tremuloides) were present. The herbaceous layer was composed of forbs and grasses with Bracken Fern most common.

5.2.8 UPLAND FORB/GRASSLAND (UF/G): This cover type also tends to be transitional over time and occupied areas disturbed by mowing and top soil removal. A variety of grasses (Gramineae) dominated the investigated stands.

5.2.9 RIVERINE (RIV): The French River and its tributaries were placed in this cover type. In general the French River is sluggish and has a muddy bottom, although a few areas were faster and had a gravel substrate. The river is largely devoid of vegetation, but overhanging stems from adjacent cover types provided some cover. Occasional patches of submerged vascular plants and floating leaved plants were present. Aquatic mosses were attached to stones in faster flowing reaches.

5.2.10 DISTURBED: The most conspicuous disturbed areas, both in terms of size and nature of disturbance, were the gravel pits. Except for Belted Kingfisher which could use gravel banks as nesting sites, the disturbed areas were assumed to offer no wildlife values.

5.3 COVER TYPE MAPPING

Stereoscopic pairs of aerial photographs were evaluated using a stereoscope and cover type boundaries drawn onto photo overlays. This information was transferred to scale with a vertical sketch master onto a topographic base map (1:4800, 5 foot contour intervals). All boundaries were ground truthed and revised as necessary from field observations. The resulting map was used as a basis for area determinations by planimetery. Figure 5.1 illustrates the vegetational mosaic that was mapped.

The pattern of wetland cover types correlates with topography and moisture gradients. Riverine and palustrine emergent wetland marsh of course constitutes the wettest environments since they are permanently inundated. Palustrine emergent wetland sedge areas occur primarily in the lower basin adjacent and up gradient of the marsh. This area remains inundated longer than other seasonally inundated cover types. The palustrine scrub/shrub cover type (non-bog) is located around the perimeter of the emergent wetlands and also adjacent to the river in the upper basin. It is inundated for almost as long as the sedge wetland. The palustrine deciduous forested wetland is inundated for the shortest period of time. Red Maple is not tolerant of prolonged inundation. The pattern of upland cover types is probably a product of past forestry operations and other sources of disturbance.

5.4 COVER TYPE AREAS

Cover type areas were determined by planimetering each unit twice with an acceptable tolerance of .005 planimeter units. The readings were averaged and totaled for each cover type. The data was converted to acres and rounded off to the nearest acre. Table 5.1 presents the results of this analysis.

TABLE 5.1: TOTAL COVER TYPE AREAS (ACRES) PRESENT IN THE STUDY SITE.

COVER TYPE	AREA
PFO1	65
PFO4	23
PSS	62
PEMS	10
PEMM	18
UFO1	384
UFO4	77
USS	17
UF/G	25
RIV	13
DISTURBED	100
TOTAL	794

The palustrine scrub/shrub wetland is made up of 17 acres of bog and 45 acres of non-bog vegetation.

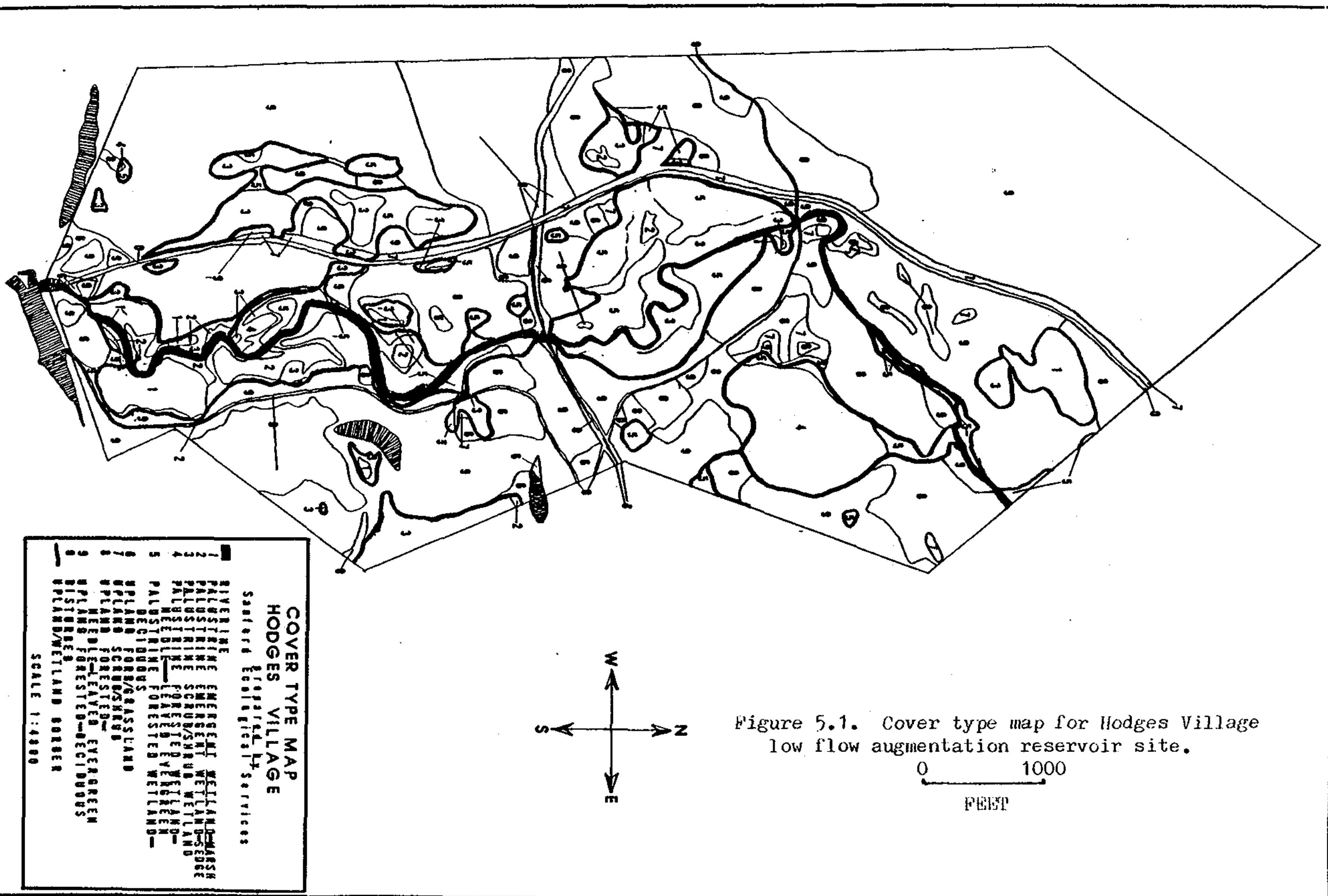

Figure 5.1. Cover type map for Hodges Village low flow augmentation reservoir site.

6. FIELD EVALUATIONS

6.1 HSI MODELS

Habitat Suitability Index models developed by the U.S. Fish and Wildlife Service were utilized in this analysis. All of the evaluation species models were in draft form. They were carefully reviewed and a number of them modified for application to Hodges Village. In many cases, the models provided a range of suitability indices for a specified parameter value; and modification simply involved selecting a single response curve. This was done by the H.E.P. team using best professional judgement. Two of the models, Red-Backed Vole and Belted Kingfisher, were modified in other ways. These modifications were provided to the H.E.P. team in letter format and are only briefly discussed here.

Considerable snap-trap data for Red-Backed Vole was available to Sanford Ecological Services from a site in Fall River, Massachusetts, which had many similar cover types to Hodges Village. This snap-trap survey was conducted by Dr. W. Mautz who provided major input into modifying the HSI model. The HSI model was applicable to deciduous forest, deciduous forested wetland, and deciduous tree savanna cover types. The results of the snap-trap survey indicated that the model should be extended to both upland and wetland scrub-shrub cover types. It also indicated that the draft model's water value component was overly severe in that the suitability index dropped to low values with distance from water or saturated soil. This response was modified to result in a higher water value suitability index for uplands. The draft model also indicated a reduction in suitability with very high litter ground cover; a response inconsistent with snap-trap survey results. This parameter was redefined to debris, rather than litter in general, and the index maintained at 1.0 for very high debris cover values. The alteration in the debris response curve had no practical effect on the Hodges Village analysis since high debris cover areas were not encountered.

The initial Belted Kingfisher model available to Sanford Ecological Services was applicable to tree, shrub and herb dominated wetlands. A subsequent draft limited applicability to riverine and lacustrine systems. Mr. Trevor Lloyd-Evans of Manomet Bird Observatory suggested that all wetland cover types at Hodges Village would potentially be used by the bird. However, the bird forages in water and many of the wetlands possessed only small pools. For this reason an additional water value parameter was added. The suitability index for this parameter varied linearly from 0 to 1 with the % of the total land surface area occupied by standing water. In the original draft, perch site availability was depicted as a limiting value. Mr. Lloyd-Evans felt that the parameter was overly limiting given the fact that the Belted Kingfisher is known to hover over water in the absence of perch sites. Mr. Lloyd-Evans designed a response histogram which was not as severe as the original draft and which was used in this analysis. This response histogram is similar in many respects to the response histogram incorporated into the second draft of the model.

6.2 SALIENT PARAMETERS AND METHODS EMPLOYED

6.2.1 SAMPLE RANDOMIZATION: Sampling stations were established in each cover type and salient parameters measured or estimated. Station locations were random and chosen by using a table of random numbers to establish coordinates on the base map. Randomization was restricted in two ways. A preset number of stations was assigned to each cover type and each cover type sampled independently of other cover types. Each station was restricted in size and shape such that it fell entirely witnin the cover type being sampled. No further restrictions were placed on stations in wetland cover types. However, a further restriction was placed on upland cover types. A portion of the samples for upland cover types were required to fall into impacted areas. Since a low proportion of the upland cover types were projected as impact areas, without this restriction there would have been a very low chance of stations falling into the upland impact zones.

6.2.2 SAMPLE NUMBERS: Reliability standards and sample size determinations for H.E.P. analyses are discussed by the U.S. Fish and Wildlife Service (ESM 102, 1980). This document states: "Reasonable reliability standards for most HEP analyses are 25% relative precision and 90% confidence level." Sample size based on random sampling for HSI values is given by the formula:

$$n = \frac{Z_C^2 \cdot p \cdot q}{D^2}$$

where n = the recommended sample size

Z_C = the value obtained from a standardized normal table. C is the specified confidence level.

p = the estimate of the parameter mean expressed in decimal form.

q = 1 - p.

D = the relative precision (ESM 102, 1980).

For any specified confidence level and relative precision, n will reach maximum when p = 0.5. Assuming p = 0.5, n will equal 6.6 when the reliability standards above are applied. A sample size of 7 was therefore chosen as a goal for each cover type. This goal was achieved in 6 of the 9 major cover types sampled. Three cover types received less than 7 samples because of limited cover type acreage within the study site. Palustrine needle-leaved evergreen forested wetlands were sampled at three stations. This cover type was not expected to be impacted by the project. Upland scrub-shrub was sampled at 5 stations; upland forb/grassland was sampled at 6 stations. Approximately 4% of the projected impact area was comprised of these two cover types.

6.2.3 HSI PARAMETERS AND SAMPLING METHODS: Each of the 15 evaluation species HSI models required evaluation of several different habitat characteristics. In total, over 40 different parameters were sampled. These parameters and the methods employed are listed in Table 6.1. Details of methods used are described by the U.S. Fish and Wildlife Service (1981 B).

TABLE 6.1: SPECIES EVALUATION PARAMETERS AND METHODS.

1. *Clethrionomys gapperi* - Southern Red-Backed Vole

Cover type usage: PFO1
PSS
UFO1
USS

Parameter	Method
Water value:	
Distance to water or saturated soil.	Ocular estimation; map.
Cover and reproductive value:	
% tree canopy closure.	Line intercept.
% of ground covered by Vole cover (debris, stumps, etc.).	Line intercept.

2. *Mustela vison* - Mink

Cover type usage: PFO1
PFO4
PSS
PEM
RIV
Uplands within 100 m of Wetlands

Parameter	Method
Food/cover:	
% tree and/or shrub canopy closure.	Line intercept.
% of year with surface water present.	Ocular estimation; records.
% of wetland basin dominated by persistent emergent herbaceous vegetation.	Ocular estimation.
% tree and/or shrub canopy closure within 100 m of water's or wetland's edge.	Line intercept.
Shoreline development factor.	Map.

3. <u>Ondatra zibethicus</u> - Muskrat

Cover type usage: PEM
RIV

Parameter	Method
Cover:	
% canopy cover persistent emergent herbaceous vegetation.	Ocular estimation.
Bank soil texture.	Soil texture by feel.
% stream gradient.	Topographic map.
Food:	
% canopy closure of emergent vegetation.	Line intercept.
% canopy cover of emergent vegetation comprised of cattail.	Ocular estimation.
% herbaceous canopy cover within 10 m of open water's edge.	Line intercept.
Water:	
Water regime (relative permanence).	Ocular estimation; records.

4. <u>Desmognathus fuscus fuscus</u> - Northern Dusky Salamander

Cover type usage: PFO1
PFO4
RIV
UFO1
UFO4

Parameter	Method
Water:	
Distance to suitable water.	Ocular estimation; map.
Cover:	
Abundance of rocks, logs, other suitable cover in water.	Ocular estimation.
Abundance of cover objects on land.	Ocular estimation.

5. *Rana sylvatica* - Wood Frog

Cover type usage: PFO1
UFO1

Parameter	Method
Cover:	
% of ground covered by litter.	Line intercept.
% herbaceous canopy cover.	Line intercept.
Number of refuge sites per acre.	Quadrat.
Soil moisture regime.	Ocular estimation.
Reproduction:	
Distance to permanent water.	Ocular estimation; map.

6. *Chelydra serpentina* - Snapping Turtle

Cover type usage: PFO1
PSS
PEM
RIV

Parameter	Method
Food and Foraging Cover:	
% aquatic vegetative cover in littoral zone.	Ocular estimation.
Water:	
Water regime (relative permanence).	Ocular estimation; records.
Water current.	Timed float.
Aquatic substrate:	Ocular estimation.

7. *Butorides striatus* - Green Heron

Cover type usage: PFO1
PSS
PEM
RIV

Parameter	Method
Food:	
Aquatic substrate.	Feel.
% of water area <10" deep.	Graduated rod.
% emergent herbaceous canopy cover in littoral zone.	Ocular estimation.

7. Green Heron Continued

Parameter	Method
Food:	
% of water surface covered by logs, trees, or woody vegetation within 1 m of water's surface.	Ocular estimation.
Water:	
Water regime (relative permanence)	Ocular estimation; records.
Water current.	Float.
Reproduction:	
Distance to clumps of deciduous shrubs/ trees.	Ocular estimation.

8. Anas rubripes - Black Duck

Cover type usage: PFO1
PFO4
PSS
PEM

Parameter	Method
Brood:	
% of water area <18" deep.	Graduated rod.
% of water area that is open.	Ocular estimation.
% canopy cover of woody and/or persistent vegetation.	Ocular estimation.
Breeding:	
% of water area <18" deep.	Graduated rod.
Edge index.	Ocular estimation; map.

9. Aix sponsa - Wood Duck

Cover type usage: PFO1
PSS
PEM
RIV
Upland Forested - Deciduous

Parameter	Method
Nesting:	
Number of potentially suitable tree cavities per acre.	Quadrat.

9. Wood Duck Continued

Parameter	Method
Brood:	
% of the water surface covered by potential brood cover.	Ocular estimation.
Interspersion:	
Distance between cover types.	Map.
Relative area of cover types.	Polar planimeter.

10. *Buteo platypterus* - Broad-Winged Hawk

Cover type usage: PFO1
PFO4
PSS
UFO1
UFO4
USS
UF/G

Parameter	Method
Food:	
% herbaceous canopy cover.	Line intercept.
Average height of herbaceous canopy.	Graduated rod.
% shrub crown cover.	Line intercept.
Water:	
Distance to water.	Ocular estimation; map.
Cover and reproduction:	
Distance to forest opening.	Ocular estimation; map.
Average height of overstory trees.	Merritt hypsometer.
Interspersion:	
Distance between cover types.	Map.
Relative cover type abundance.	Polar planimeter.

11. *Philohela minor* - American Woodcock

Cover type usage: PFO1
PSS
UFO1
UF/G

11. American Woodcock Continued

Parameter	Method
Food:	
% ground covered by litter.	Line intercept.
% herbaceous canopy cover.	Line intercept.
Soil texture.	Soil feel.
Soil moisture.	Soil feel.
Soil compaction.	Probe.
Water:	
Distance to water.	Ocular estimation; map.
Cover:	
Overstory forest size class.	dbh - Biltmore stick.
% canopy closure of overstory trees.	Line intercept.
% shrub crown cover.	Line intercept.
% herbaceous canopy cover.	Line intercept.
Reproduction:	
% herbaceous canopy cover.	Line intercept.
Average height of herbaceous canopy.	Graduated rod.
% canopy coverage of trees and shrubs.	Line intercept.
Interspersion:	
Distance to cover type with missing life requisite.	Ocular estimation; map.
Relative abundance of cover types.	Polar planimeter.

12. _Megaceryle alcyon_ - Belted Kingfisher

Cover type usage: PFO1
PFO4
PSS
PEM
RIV

Parameter	Method
Food:	
Water turbidity.	Records.
Perch site availability.	Ocular estimation.
Water depth.	Graduated rod.
Vegetation covering water.	Ocular estimation.
Reproduction:	
Perch site availability.	Ocular estimation.
Distance from water to possible nest site.	Ocular estimation; map.

12. Belted Kingfisher Continued

Parameter	Method
Water:	
% of cover type with available lentic habitat.	Ocular estimation.

13. *Picoides pubescens* - Downy Woodpecker

Cover type usage: PFO1
PFO4
UFO1
UFO4

Parameter	Method
Food:	
Basal area.	Bitterlich variable radius.
Reproduction:	
Number of snags >15 cm dbh per acre.	Quadrat.

14. *Dendroica petechia* - Yellow Warbler

Cover type usage: PSS
USS

Parameter	Method
Reproduction:	
% deciduous shrub crown cover.	Line intercept.
Average height of deciduous shrub canopy.	Graduated rod.
% deciduous shrub canopy comprised of hydrophytic shrubs.	Line intercept.

15. *Melospiza georgiana* - Swamp Sparrow

Cover type usage: PFO1
PFO4
PSS
PEM

15. Swamp Sparrow Continued

Parameter	Method
Cover and reproduction:	
% scrub crown cover.	Line intercept.
Average height of scrubs.	Graduated rod.
% deciduous trees.	Line intercept.
% herbaceous canopy cover.	Line intercept.
Average height of herbaceous vegetation.	Graduated rod.
Interspersion:	
Distance to herb-dominated wetland.	Ocular estimation: map.
Distance to scrubland or treeland.	Ocular estimation: map.

Observations at each sampling station extended over 20,000 to 30,000 square feet. Line intercept transects were randomly located within each station. Three 100 foot line intercepts were established for tree canopy and shrub canopy samples; three 30 foot line intercepts were established for the herbaceous layer samples. Line intercepts were parallel with each other; their direction was selected randomly; and the distances between lines were randomly determined. Randomization was restricted by requiring all lines to stay within the cover type being sampled. Debris and litter cover were sampled using the herbaceous layer line intercept transects. Three random points on each transect line were selected and the nearest plant height measured for each layer of the vegetation. These same points were used as basal area sampling points and for measuring diameter at breast height for nearest trees. Wood Duck cavity and snag abundance were estimated using a 100 X 60 foot quadrat placed over each line transect. Wood Frog refuge sites were estimated from a 30 X 30 foot quadrat placed randomly along each line transect. Size of the Wood Frog refuge site quadrat was reduced when sites were to numerous to count in the 30 X 30 quadrat. Ocular estimations were made over the entire station.

Summary data tables are presented in Appendix B.

7. BASELINE ANALYSIS

7.1 INTRODUCTION

HSI values were calculated by exercising evaluation species models. By definition, the HSI is linearly related to carrying capacity. An HSI value of 1 indicates a long term population density equal to that which occurs in an optimum habitat. An HSI value is determined from Suitability Indices (SI's). An SI is generally a non-linear function expressing a relationship between the species and particular habitat conditions using "limiting factor" concepts. Once HSI values were determined for each station, they were averaged to express a mean HSI for each cover type. A mean weighted HSI for the study site was determined based on the relative area of each cover type. Details of the methods of calculation may be found in the U.S. Fish and Wildlife Service HSI models and ESM 102 (1980).

7.2 RED-BACKED VOLE

HSI values for Red-Backed Vole appear in Table 7.1. The mean weighted HSI for the study area was 0.30. As could be expected, wetland habitat was generally better than upland habitat. Red Maple swamp (PFO1) offered the best habitat on the site. In forested cover types, the most important factor limiting the quality of habitat was a low abundance of suitable vole cover (stumps, logs, other debris). In shrub areas, both vole cover and a lack of tree canopy interacted to reduce habitat quality.

TABLE 7.1: STATION AND MEAN HSI VALUES FOR RED-BACKED VOLE.

Cover	Station Number								Mean
Type	1	2	3	4	5	6	7	8	
PFO1	0.65	0.31	0.14	0.64	0.51	1.00	0.75		0.57
UFO1	0.33	0.05	0.31	0.22	0.70	0.07	0.17		0.26
PSS*	0.00	0.00	0.00	0.58	0.58	0.58	0.40	0.36	0.30
USS	0.46	0.03	0.44	0.26	0.00				0.24

* Stations 1 & 2 were in bog areas, Stations 3 - 8 were in non-bog areas. Mean is weighted by areas.

7.3 MINK

HSI values for Mink appear in Table 7.2. The mean weighted HSI for the study area was 0.84. In forested regions, a lack of prolonged flooding limited habitat quality. This parameter reduced habitat quality at only one of the shrub wetland stations while low shrub canopy closure reduced habitat quality at 5 of the non-bog stations. Habitat quality was excellent in herbaceous wetlands and only two of the 9 stations appeared to be below optimum. The French River provided optimum conditions.

TABLE 7.2: STATION AND MEAN HSI VALUES FOR MINK.

Cover Type	Station Number 1	2	3	4	5	6	7	8	Mean
PF01	0.71	0.75	1.00	0.75	1.00	1.00	1.00		0.89
PF04	0.50	0.00	1.00						0.50
PSS*	1.00	1.00	0.88	0.84	0.75	0.80	0.83	0.00	0.77
PEMM	1.00	1.00	1.00	1.00					1.00
PEMS	0.75	1.00	0.95	1.00	1.00				0.94
RIV	1.00	1.00	1.00	1.00	1.00	1.00	1.00		1.00

* Stations 1 & 2 were in bog areas, Stations 3 - 8 were in non-bog areas. Mean is weighted by areas.

7.4 MUSKRAT

HSI values for Muskrat appear in Table 7.3. The mean weighted HSI for the study area was 0.49. The French River was limited by below optimum amounts of herbaceous vegetation within 10 meters of its bank (i.e. food availability). Although PEMM habitat had permanent standing water, conditions were limited by very sparse amounts of Cat-Tail, an important food resource for the animal. The Tussock Sedge wetlands (PEMS) provided low habitat quality because of seasonal rather than permanent flooding.

TABLE 7.3: STATION AND MEAN HSI VALUES FOR MUSKRAT.

Cover Type	Station Number 1	2	3	4	5	6	7	Mean
RIV	0.65	0.44	0.23	0.34	0.35	0.77	0.76	0.51
PEMM	0.63	0.63	0.63	0.63				0.63
PEMS	0.20	0.20	0.20	0.20	0.20			0.20

7.5 DUSKY SALAMANDER

HSI values for Dusky Salamander appear in Table 7.4. The mean weighted HSI for the study area was 0.17. Since the animal requires a moist environment for reproduction, upland habitat quality was limited by distance to moist areas. A low abundance of rocks, logs, etc. which were suitable as refuge sites for the salamander limited habitat quality elsewhere.

TABLE 7.4: STATION AND MEAN HSI VALUES FOR DUSKY SALAMANDER.

Cover Type	Station Number 1	2	3	4	5	6	7	8	Mean
PF01	0.70	0.70	0.60	0.44	0.70	7.00	0.70		0.65
PF04	0.95	0.00	0.70						0.55
UF01	0.00	0.00	0.08	0.00	0.00	0.00	0.02		0.01
UF04	0.00	0.00	0.42	0.02	0.00	0.00	0.00		0.06
PSS*	0.70	0.80	0.60	0.70	0.60	0.80	0.00	0.02	0.53
RIV	0.60	0.60	0.60	0.60	1.00	1.00	1.00		0.77

* Stations 1 & 2 were in bog areas, Stations 3 - 8 were in non-bog areas. Mean is weighted by areas.

7.6 WOOD FROG

HSI values for Wood Frog appear in Table 7.5. The mean weighted HSI for the study area was 0.83. The high suitability was confirmed by the frequent observations of these frogs during the field work. As expected, wetlands provided better habitat than uplands because of higher soil moisture. Wetland soils however were overly moist for optimum conditions. This coupled with lower than optimum herbaceous cover reduced the overall habitat quality of the Red Maple Wetlands.

TABLE 7.5: STATION AND MEAN HSI VALUES FOR WOOD FROG.

Cover Type	1	2	3	4	5	6	7	Mean
PF01	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
UF01	1.00	0.32	1.00	1.00	0.32	1.00	1.00	0.81

7.7 SNAPPING TURTLE

HSI values for Snapping Turtle appear in Table 7.6. The mean weighted HSI for the study area was 0.20. In all cover types but PEMM and RIV, habitat suitability was low or zero because of a lack of permanent water. Habitat in marsh areas (PEMM) was reduced from optimum because of an excessively high abundance of aquatic vegetation. The French River was relatively poor habitat because of a lack of aquatic vegetation.

TABLE 7.6: STATION AND MEAN HSI VALUES FOR SNAPPING TURTLE.

Cover Type	Station Number 1	2	3	4	5	6	7	8	Mean
PFO1	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
PSS*			1.00	1.00	0.00	0.00	0.00	0.00	0.24
PEMM	1.00	0.85	0.87	1.00					0.93
PEMS	0.00	0.00	0.00	0.00	0.00				0.00
RIV	0.37	0.01	0.55	0.01	0.00	0.26	0.00		0.17

* Stations 1 & 2 were in bog areas, Stations 3 - 8 were in non-bog areas. Mean is weighted by areas.

7.8 GREEN HERON

HSI values for Green Heron appear in Table 7.7. The mean weighted HSI for the study area was 0.76. Red Maple wetlands (PFO1) were generally less than optimum habitat because of only seasonal instead of permanent flooding. The shrub wetlands (PSS) were limited by seasonal flooding at two stations. Three shrub wetland stations were limited by parameters which estimated food value. Low abundance of herbaceous emergents in the littoral zone was the most important food parameter which lowered the HSI values. PEMM provided optimum habitat. PEMS habitat quality was lowered at two stations by seasonal flooding and at three stations by parameters which estimated food value. RIV provided excellent habitat, although at three stations the food value was less than optimum.

TABLE 7.7: STATION AND MEAN HSI VALUES FOR GREEN HERON.

Cover Type	Station Number 1	2	3	4	5	6	7	8	Mean
PFO1	0.20	0.87	0.87	0.87	0.87	1.00	0.68		0.77
PSS*	0.00	1.00	1.00	1.00	0.87	0.87	0.20	0.20	0.64
PEMM	1.00	1.00	1.00	1.00					1.00
PEMS	0.47	0.86	0.76	0.87	0.87				0.77
RIV	0.94	1.00	1.00	0.77	0.89	1.00	1.00		0.94

* Stations 1 & 2 were in bog areas, Stations 3 - 8 were in non-bog areas. Mean is weighted by areas.

7.9 BLACK DUCK

HSI values for Black Duck appear in Table 7.8. The mean weighted HSI for the study area was 0.39. Available brood habitat was limiting for all cover types except PEMM. Brood habitat was a function of water depth, % of water which was open, and % canopy cover of woody and/or persistent vegetation. Water depth was usually not limiting. Variable combinations of the other two parameters resulted in lower than optimum brood habitat. PEMM was limited by breeding habitat because of a low edge index.

TABLE 7.8: STATION AND MEAN HSI VALUES FOR BLACK DUCK.

Cover Type	Station Number 1	2	3	4	5	6	7	8	Mean
PFO1	0.00	0.00	0.87	1.00	0.00	0.25	0.62		0.39
PEMM*	--	--	--	--					0.56
PSS**	0.25	0.00	1.00	0.25	0.75	0.25	0.00	0.00	0.31
PEMS	0.00	1.00	1.00	0.63	0.37				0.60

* PEMM limited by breeding habitat which is a function of water depth and edge index. Edge index was determined from cover type map and calculated for Stumpy Pond and the rest of PEMM in the lower basin separately. Hence HSI values for each station are not calculated. The mean HSI value is a weighted average for Stumpy Pond and the lower basin PEMM.

** Stations 1 & 2 were in bog areas, Stations 3 - 8 were in non-bog areas. Mean is weighted by areas.

7.10 WOOD DUCK

The % of life requisite support which was available in each cover type, the suitability indices for nesting and brooding, and the overall HSI value is presented in Table 7.9 The % of available brooding habitat was limiting in the study site. This life requisite was estimated from the % of water covered by brood cover and the overall amount of brooding space as a % of available habitat.

TABLE 7.9: % AVAILABLE LIFE REQUISITE SUPPORT, SUITABILITY AND HSI VALUES FOR WOOD DUCK.

Cover Type	Nest	Brood	
UFO1	6.3	0.0	
PFO1	2.7	5.8	
PSS	0.0	4.4	
PEMM	0.0	2.5	
PEMS	0.0	1.1	
RIV	0.0	0.9	
TOTAL	9.0	14.7	
SUITABILITY INDEX	.47	.16	HSI = 0.16

7.11 BROAD-WINGED HAWK

The % of life requisite support which was available in each cover type, the suitability indices for food and cover/reproduction, and the overall HSI value is presented in Table 7.10. Based on the % available life requisite support necessary for optimum habitat, conditions in the study site represented optimum habitat for this bird.

TABLE 7.10: % AVAILABLE LIFE REQUISITE SUPPORT, SUITABILITY AND HSI VALUES FOR BROAD-WINGED HAWK.

Cover Type	Food	Cover & Reproduction	
PFO1	9.2	10.0	
PFO4	3.5	3.5	
UFO1	48.2	58.8	
UFO4	11.1	11.8	
PSS	7.4	0.0	
USS	1.8	0.0	
UF/G	3.2	0.0	
TOTAL	84.4	84.1	
SUITABILITY INDEX	1.0	1.0	HSI = 1.00

7.12 AMERICAN WOODCOCK

The % of life requisite support which was available in each cover type, the suitability indices for food, water, cover, and reproduction, and the overall HSI value is presented in Table 7.11. Reproduction was limiting in the study site because of the low amount of Forb/Grassland available for courtship activities.

TABLE 7.11: % AVAILABLE LIFE REQUISITE SUPPORT, SUITABILITY AND HSI VALUES FOR AMERICAN WOODCOCK.

Cover Type	Food	Water	Cover	Reproduction	
UFO1	46.5	63.0	45.1	0.0	
PFO1	11.1	12.1	8.1	0.0	
PSS	8.2	11.6	9.2	0.0	
UF/G	2.4	4.7	0.0	3.4	
TOTAL	68.2	91.4	62.4	3.4	
SUITABILITY INDEX	1.00	0.91	1.00	0.34	HSI = 0.34

7.13. BELTED KINGFISHER

HSI values for Belted Kingfisher appear in Table 7.12. The mean weighted HSI for the study area was 0.19. The French River had near optimum habitat for this bird although only 1 or 2 pairs could be expected in the study site because of territorial behavior. At three of the RIV stations, the HSI value was slightly lower than optimum because of excessive overhanging vegetation which would have inhibited foraging activities. The forested wetlands had low HSI values because of limited amounts of standing water for foraging activities. This factor also limited the usefulness of the shrub (PSS) and Sedge (PEMS) wetlands. PEMM provided adequate water resources, however much of the water was covered by vegetation which reduced the quality of foraging habitat.

TABLE 7.12: STATION AND MEAN HSI VALUES FOR BELTED KINGFISHER.

Cover Type	Station Number 1	2	3	4	5	6	7	8	Mean
RIV	1.00	1.00	0.93	1.00	0.91	0.91	1.00		0.96
PEMM	0.87	0.57	0.57	0.49					0.63
PEMS	0.00	0.50	0.50	0.50	0.39				0.38
PSS*	0.05	0.00	0.01	0.00	0.25	0.35	0.00	0.00	0.08
PF01	0.00	0.15	0.00	0.15	0.00	0.13	0.01		0.06
PF04	0.00	0.00	0.01						0.00

* Stations 1 & 2 were in bog areas, Stations 3 - 8 were in non-bog areas. Mean is weighted by areas.

7.14. DOWNY WOODPECKER

HSI values for Downy Woodpecker appear in Table 7.13. The mean weighted HSI for the study area was 0.76. Red Maple wetlands (PFO1) offered the best quality habitat. Only one station in this over type was less than optimal. The mixed oak uplands (UFO1) provided the next best quality habitat. Food was evaluated by basal area and in four of the UFO1 stations, basal area was excessive. Coniferous cover types (PFO4 & UFO4) were less suitable. Snags were not as numerous as in deciduous cover types and this resulted in limitations on reproductive suitability at stations in both coniferous types. High basal area contributed to low suitability at remaining coniferous stations.

TABLE 7.13: STATION AND MEAN HSI VALUES FOR DOWNY WOODPECKER.

Cover Type	Station Number 1	2	3	4	5	6	7	Mean
PFO1	1.00	1.00	1.00	1.00	1.00	1.00	0.73	0.96
PFO4	0.49	0.00	0.50					0.33
UFO1	0.50	1.00	0.50	1.00	0.89	1.00	0.76	0.81
UFO4	0.50	0.50	0.63	0.74	0.00	0.49	0.53	0.48

7.15. YELLOW WARBLER

HSI values for Yellow Warbler appear in Table 7.14. The mean weighted HSI for the study area was 0.50. HSI values were based upon three parameters used to evaluate reproductive suitability; these were (1) % deciduous shrub cover, (2) average height of shrubs, and (3) % hydrophytic shrubs. In shrub wetlands, shrub cover and height were to low for optimum habitat. In shrub uplands, stations 1 and 2 were high quality habitats. These stations were adjacent to wetlands. The remaining three stations were limited by low shrub heights and a low proportion of hydrophytic shrubs.

TABLE 7.14: STATION AND MEAN HSI VALUES FOR YELLOW WARBLER.

Cover Type	Station Number 1	2	3	4	5	6	7	8	Mean
PSS*	0.38	0.21	0.45	0.69	0.72	0.27	0.70	0.62	0.50
USS	0.87	1.00	0.23	0.21	0.15				0.49

* Stations 1 & 2 were in bog areas, Stations 3 - 8 were in non-bog areas. Mean is weighted by areas.

7.16 SWAMP SPARROW

HSI values for Swamp Sparrow appear in Table 7.15. The mean weighted HSI for the study area was 0.67. The Swamp Sparrow usually maintains its territory over shallow water and herbaceous wetlands. In forested cover types, habitat quality was limited primarily by distance to herbaceous wetlands. At only two stations in PSS were distances to herbaceous wetlands limiting. Most of the other stations were optimum. Conditions in PEMM and PEMS were excellent except for height of the herbaceous canopy which was not high enough to be optimum.

TABLE 7.15: STATION AND MEAN HSI VALUES FOR SWAMP SPARROW.

Cover Type	Station Number 1	2	3	4	5	6	7	8	Mean
PFO1	0.50	0.50	0.81	0.50	0.50	0.50	0.50		0.54
PFO4	0.50	0.43	0.50						0.48
PSS*	0.50	0.63	1.00	1.00	0.81	0.50	1.00	1.00	0.80
PEMM	0.84	0.63	0.84	0.89					0.80
PEMS	0.84	0.91	0.79	0.97	0.97				0.90

* Stations 1 & 2 were in bog areas, Stations 3 - 8 were in non-bog areas. Mean is weighted by areas.

8. FUTURE CONDITIONS WITHOUT THE PROJECT

8.1 ASSUMPTIONS

Future conditions have been predicted based on a set of assumptions related to vegetation dynamics (succession) and current land use policy. It has been assumed that vegetation will change in patterns similar to known successional trends except when perturbations induced by land use activities interfere with these trends. Catastrophic events such as fire or hurricanes have not been considered. Land use policy and activities were based upon information from the Army Corps of Engineers (personal communication). This information pertains to land currently held in fee by the Corps. A portion of the study site was outside Corps land. Although not totally accurate, it has been assumed that privately held land will not change with time. This assumption was made because of the difficulty of predicting future land use on privately held property and because such an assumption would not significantly affect the accuracy of the analysis. Accuracy was not compromised because the analysis dealt with the projected impacts of the low flow augmentation project; and all impacts investigated were on Corps land. In addition the majority of the study site was on Corps land.

8.1.1 GENERAL CONSIDERATIONS: It was assumed that flood control activities would continue as in the past. Flood control has resulted in periodic inundation of large areas of project land. This inundation appears to have had a controlling influence on many of the wetland cover types and probably has prevented much of the herbaceous and shrub areas from developing a tree canopy.

It was assumed that the project area will continue to operate as a recreational area. No change in the extent of land occupied by developed recreation (ball fields, etc.) was assumed.

Forestry management was assumed to influence upland areas. The Corps intends to conduct a selective lumbering operation in both deciduous and coniferous areas. Lumbering in coniferous cover types was assumed to result in an increase in abundance of deciduous species in those areas. Lumbering in deciduous cover types was assumed to result in an increase in abundance of coniferous species. The net result was predicted to be a conversion of deciduous cover types into coniferous cover types; and coniferous cover types into deciduous cover types. This process was anticipated to take 50 years.

As part of a wildlife management program, several small forested areas covering a total of 5 acres in two years were anticipated to be cleared for forb/grassland. Forestry activities have been projected to produce 3-5 snags/acre on land which develops into upland deciduous forest (mixed oak) and 1-3 snags/acre on land which develops into upland coniferous forest (White Pine).

8.1.2 PALUSTRINE DECIDUOUS FORESTED WETLANDS (PFO1): These Red Maple dominated areas appear to have reached vegetative equilibrium. Red Maple grows in flooded areas until the shallow root system is unable to anchor the top heavy plant properly (personal observation). The tree then topples and is replaced by Red Maple in the understory. In certain areas, heavy tree fall was observed which may have been a result of flood control activities. Future conditions were predicted to be similar to baseline conditions within this cover type. No change in acreage has been anticipated.

8.1.3 PALUSTRINE NEEDLE-LEAVED EVERGREEN FORESTED WETLANDS (PFO4): The Atlantic White Cedar area was located near the upper basin in the study site and has been inundated in the past only by exceptionally high pool stages. The area, if left undisturbed, should retain its general characteristics. The dense tree canopy will continue to depress understory growth although the trees themselves will probably self thin. No change in acreage has been anticipated.

8.1.4 PALUSTRINE SCRUB-SHRUB (PSS): Bog areas will normally change to more mesophytic vegetation. However no major changes either in characteristics or acreage have been anticipated over the time frame of this project. Non-bog areas appear to have been controlled by flood control activities which have prevented normal succession. Since flood control is assumed to occur over the life of the project, no alterations in this cover type have been projected.

8.1.5 PALUSTRINE EMERGENT WETLANDS (PEM): Except for Stumpy Pond, these herbaceous wetlands also appear to be a result of flood control activities or, prior to Hodges Village Dam, of Mill Pond. The project life is not long enough for sedimentation to alter basic characteristics. However, small patches of Cattail were observed which are anticipated to expand. These patches were along the perimeter of the marsh. It was predicted that Cattails would develop more or less continually along the perimeter as a band. Because of adverse conditions caused by alternate inundation and exposure from flood control, this process was anticipated to proceed slowly and reach conclusion within 50 years. Cattail patches were approximately 25 feet wide and this width along the marsh perimeter was assumed after 50 years. No change in acreage has been anticipated for the cover type itself.

8.1.6 UPLAND DECIDUOUS FOREST (UFO1): The mixed oak areas constituted a young, pole sized forest. Without disturbance, it would be expected that forest maturation would occur. However, the lumbering program was projected to encourage uneven growth. In addition, new growth from cut over pine forest was projected. The patterns will likely be complex, but in general an immature forest with average characteristics similar to the present cover type was projected as a best possible estimate. However, the acreage of this cover type was predicted to decrease (see Table 8.1, page 44).

8.1.7 UPLAND NEEDLE-LEAVED EVERGREEN FOREST (UFO4): For similar reasons to UFO1, this cover type was projected as maintaining its general characteristics as a best possible estimate. Acreage was predicted to increase (see Table 8.1, page 44).

8.1.8 UPLAND SCRUB-SHRUB (USS): Some of the scrub-shrub land was in a transitional state. Young tree saplings were observed within the cover type. These areas are predicted to succeed to a deciduous forested cover type. Other areas of USS were present because of herbicide spraying. It was assumed that some type of brush control would continue and that these areas would remain USS. Production of USS from forb/grassland was assumed to compensate for lost USS to forest. As a result, it was projected that the total amount of USS will remain constant.

8.1.9 UPLAND FORB/GRASSLAND (UF/G): Some of the forb/grassland was in transition to USS. Other areas were mowed and it is assumed that this activity will maintain UF/G. Other areas, because of top soil removal, were projected to change very slowly. The best estimate was that approximately half of UF/G would be lost to other cover types over 100 years. However, forestry practices were projected to add 5 acres to UF/G within two years.

8.1.10 RIVERINE (RIV): No significant changes in river characteristics were anticipated.

8.1.11 DISTURBED: Most of the disturbed areas on Corps land were dirt roads and were not projected to change.

8.2 ACREAGE PROJECTIONS

Based on assumptions listed in Section 8.1, the areas of each cover type were projected for four target years (TY): TY 0 (baseline), TY 1, TY 50, and TY 100. This information is presented in Table 8.1. When an intermediate target year occurred prior to the end point of a predicted change in acreage, the intermediate year acreage was calculated assuming a linear rate of change.

TABLE 8.1: COVER TYPE AREA (ACRES) PREDICTIONS FOR FUTURE CONDITIONS WITHOUT THE PROJECT.

Cover Type	Target Year			
	0	1	50	100
RIV	13	13	13	13
PEMM	18	18	18	18
PEMS	10	10	10	10
PSS				
Bog	17	17	17	17
Non-bog	45	45	45	45
PFO1	65	65	65	65
PFO4	23	23	23	23
UF/G	25	30	24	18
USS	17	17	17	17
UFO1	384	381	189	195
UFO4	77	75	273	273
DISTURBED	100	100	100	100
TOTAL	794	794	794	794

8.3 SPECIES EVALUATIONS

Projected HSI values, acreage, Habitat Units (HU's), and the mean weighted HSI for the study site are presented in Appendix C. Following is a discussion of evaluation species based upon these data.

8.3.1 RED-BACKED VOLE: No changes in HSI values were projected over the evaluated time span. Available vole habitat was predicted to decrease and hence HU's declined from 160 to 110 (Table C-1, Appendix c). This decline was attributed to the forestry program.

8.3.2 MINK: No change in HSI values or Mink habitat areas were projected over the evaluated time span. Therefore the HU's for each target year remained at 389 (Table C-2, Appendix C).

8.3.3 MUSKRAT: One of the cover types, PEMM, was projected to change by an increase in Cattails. Since this is an important food item, the HSI values increase as well as the HU's over the evaluated time span. An increase of 2 HU's was projected over 50 years (Table C-3, Appendix C).

8.3.4 DUSKY SALAMANDER: Although basic habitat characteristics critical to this Salamander were not projected to change, the ratio and quantity of various cover types which the animal uses were predicted to vary with time as a result of foresty practices. The net result was a small increase in available HU's from 106 to 116 (Table C-4, Appendix C).

8.3.5 WOOD FROG: Basic habitat characteristics critical to the frog were not projected to change. However, the quantity of habitat and ratio of usable cover types were predicted to change because of foresty practices. The net result is a significant reduction in available HU's; from 373 to 220 (Table C-5, Appendix C).

8.3.6 SNAPPING TURTLE: No changes in HSI values were projected over the evaluated time span. Since available turtle habitat was not projected to change, the HU's for each target year remained unaltered (Table C-6, Appendix C).

8.3.7 GREEN HERON: No changes in HSI values were projected over the evaluated time span. Since available heron habitat was not projected to change, the HU's for each target year remained unaltered (Table C-7, Appendix C).

8.3.8 BLACK DUCK: No changes in HSI values were projected over the evaluated time span. Since available duck habitat was not projected to change, the HU's for each target year remained unaltered (Table C-8, Appendix C).

8.3.9 WOOD DUCK: Of the six cover types on the site which Wood Duck can utilize, significant loss of UFO1 was projected to occur because of forestry practices. However, Wood Duck is limited by available brood habitat and UFO1 does not function for brooding. Brood habitat was projected to be improved by growth of Cattails around the perimeter of PEMM. Therefore, an increase in the HSI was projected which compensated for the loss of UFO1 and there was predicted a slight increase in available HU's; from 88 to 91 (Table C-9, Appendix C).

8.3.10 BROAD-WINGED HAWK: Although the ratio of usable cover types was projected to change, no change in total habitat was predicted. The HSI was expected to remain optimum and no change in HU's was anticipated (Table C-10, Appendix C).

8.3.11 AMERICAN WOODCOCK: Available habitat was anticipated to decrease after TY 1 as a result of forestry practices converting UFO1 to UFO4. However, woodcock was shown to be limited by reproductive resources. Forestry practices will improve these resources initially. Succession of forb/grassland to shrub or forest was predicted to ultimately reduce reproductive resources over the years. The net result was an initial increase in HU's followed by a decline (Table C-11, Appendix C).

8.3.12 BELTED KINGFISHER: No changes in HSI values were projected over the evaluated time span. Since available Kingfisher habitat was not projected to change, the HU's for each target year remained unaltered (Table C-12, Appendix C).

8.3.13 DOWNY WOODPECKER: Two of the four cover types utilized were projected to change because of forestry practices. UFO1 was projected to be converted to UFO4 with 1-3 snags/acre. This number of snags is limiting and represents similar conditions to the baseline evaluation of UFO4. Baseline evaluations of UFO1 indicated higher snag density than what is predicted for the future UF01. A snag density of 3-5 snags/acre was projected. However, this snag density is close to optimum and the future HSI value for UF01 is assumed to remain constant. The change in ratio of cover types resulted in a decline in HU's because poorer quality UF04 is essentially substituted for higher quality UF01. The decline was from 418 Habitat Units to 359 (Table C-13, Appendix C).

8.3.14 YELLOW WARBLER: No changes in HSI values were projected over the evaluated time span. Since available Warbler habitat was not projected to change, the HU's for each target year remained unaltered (Table C-14, Appendix C).

8.3.15 SWAMP SPARROW: No changes in HSI values were projected over the evaluated time span. Since available Sparrow habitat was not projected to change, the HU's for each target year remained unaltered (Table C-15, Appendix C).

9. FUTURE CONDITIONS WITH THE PROJECT WITHOUT MITIGATION

9.1 ASSUMPTIONS

A description of the project was presented in Section 1.2. Features of the project which will affect wildlife habitat include clearing, stripping, and inundation. The area which will be disturbed by these activities has been designated the impact zone and is illustrated in Figure 9.1. Future conditions of land outside of the impact zone have been assumed to be identical with projections discussed in Section 8.1.

9.1.1 GENERAL CONSIDERATIONS: Clearing will occur throughout the impact zone over an area of 180 acres. This zone includes a Freeboard region around the augmentation pool which includes land between elevations 475.6 and 477.5 feet. However, the Atlantic White Cedar stand (PFO4) will not be cleared even though much of it falls within this range of elevations.

Topsoil would be stripped east of the abandoned railroad, south of Old Charlton Road (see Figure 9.1), and within the range of the augmentation pool (elevations below 475.6 feet). The total area subject to stripping was determined to be 120 acres.

Inundation would occur continuously within the range of the permanent pool (elevations below 472 feet). Seasonal inundation by the augmentation pool (between elevations 472 and 475.6 feet) will begin in May, reach a peak by the first part of June, and then slowly decline to the permanent pool level by the end of October. Pool draw down has been projected to be 0.1 feet by the beginning of July, 0.8 feet by August, 1.4 feet by September, and 3.3 feet by the beginning of October. This rate of draw down suggests that most of the land flooded by the augmentation pool will remain flooded for the majority of the growing season.

Inundation above the elevation of the augmentation pool is expected to occur as a result of storm events. This could be significant primarily when the augmentation pool is near its maximum level (June and July). However the acreage of inundated land above the augmentation pool may be limited for two reasons. First, the Corps plans to install a computerized control structure at the dam with manual override. The computer would sense an increase in pool elevation and begin releasing water (unless flood danger exists in which case the dam would be operated manually). This would attenuate the rise in pool height. Second, the topography of the augmentation reservoir and its storage capacity would contain storm runoff without inundating large (relative to present operations) areas beyond the augmentation pool. Except in unusual storm events, pool elevation can be expected to be contained within the Freeboard region. Based on present operations, impoundment above the augmentation pool can be expected to be drawn down within several days.

Inundation above the freeboard elevations as a result of unusual storm events may occur. In such cases, primarily wetlands north of the study area (including the Atlantic White Cedar area) would be inundated. Portions of wetlands north of the study area currently receive prolonged inundation for reasons

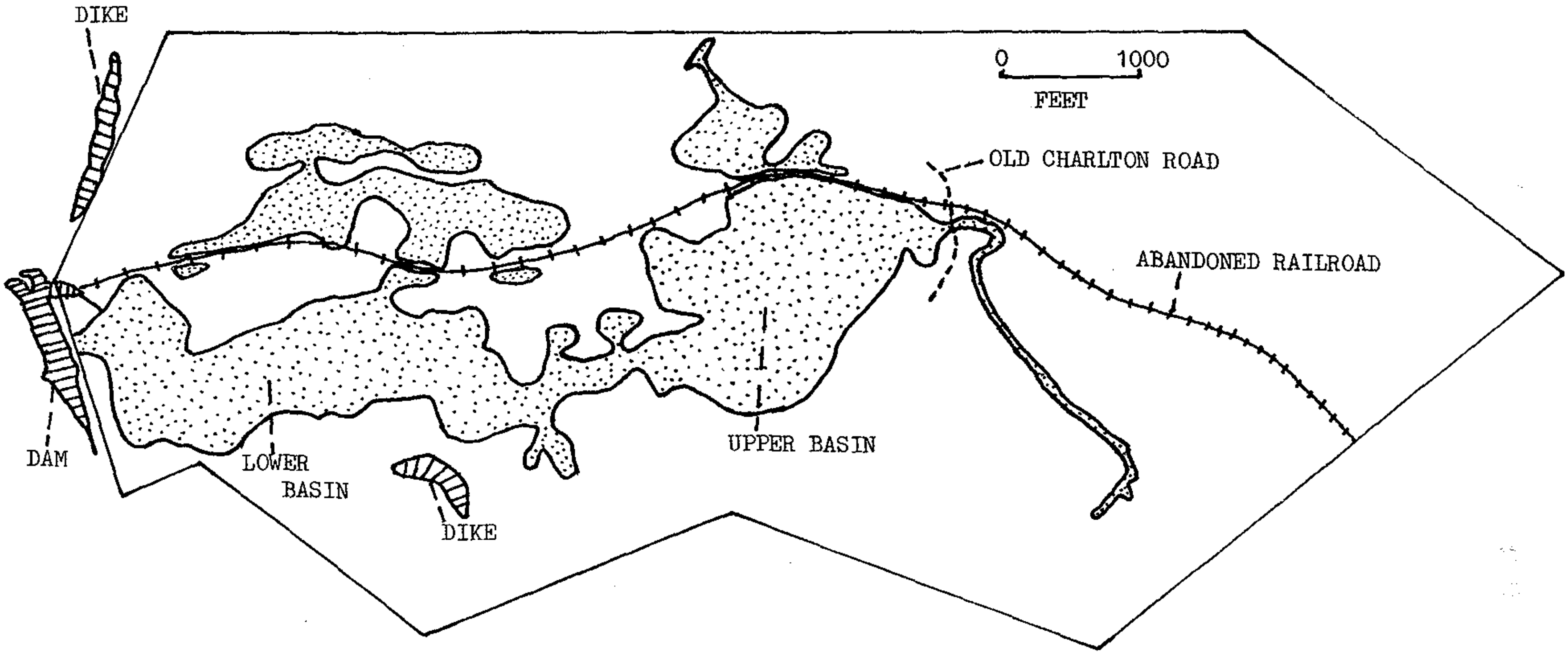

Figure 9.1 Impact zone (stippled area). The area includes the Freeboard, Augmentation Pool and Permanent Pool.

unrelated to flood control operations.

Wetland vegetation is adapted to saturated soil conditions and a several day flood is not expected to harm these cover types, at least not in a way which could be detected by a H.E.P. analysis. For this reason, clearing of the Atlantic White Cedar area has been deemed unnecessary.

9.1.2 PALUSTRINE DECIDUOUS FORESTED WETLANDS (PFO1): The Red Maple area within the study site was projected to lose 58 acres to the project. Remaining areas were projected to follow a pattern outlined in Section 8.1.2.

9.1.3 PALUSTRINE NEEDLE-LEAVED EVERGREEN FORESTED WETLANDS (PFO4): The Atlantic White Cedar area was projected to remain unaffected by the project and to follow a pattern outlined in Section 8.1.3.

9.1.4 PALUSTRINE SCRUB-SHRUB (PSS): Nine acres of bog were projected to be lost to the project. The remaining bog areas would follow a pattern outlined in Section 8.1.4. Forty-two acres of non-bog PSS were predicted to be lost by TY 1. Three acres in the Freeboard area would return to PSS within 10 years. The Freeboard region is assumed to be cleared and then allowed to revegetate, however a shrub cover would be maintained. Future assumed conditions of PSS after project development are outlined in Section 8.1.4.

9.1.5 PALUSTRINE EMERGENT WETLANDS (PEM): Eleven acres of PEMM were predicted to be lost by TY 1. Areas west of the abandoned railroad which would be cleared but not stripped were projected to develop into PEMM over a period of 35 years and thus a net increase of 24 acres was assumed. Since Cattail was observed in the region west of the railroad, it was assumed that Cattail regeneration would be prominent in a portion of the region presently occupied by bog vegetation (7 acres) and that the rest of the area would develop characteristics similar to the existing PEMM. PEMM which was not assumed impacted by the project occurred at Stumpy Pond (future conditions were described in Section 9.1.5).

All (10 acres) of the PEMS cover type were assumed lost to the project.

9.1.6 UPLAND DECIDUOUS FOREST (UFO1): Twenty acres of mixed oak upland were projected to be impacted. A portion of this area in the Freeboard region was assumed to regenerate to USS within 10 years. Habitat characteristics were assumed to resemble present USS after 10 years. Future conditions for remaining UFO1 were discussed in Section 8.1.6.

9.1.7 UPLAND NEEDLE-LEAVED EVERGREEN FOREST (UFO4). Eight acres of this cover type were projected to be impacted. A portion of this area in the Freeboard region was assumed to regenerate to USS within 10 years. Habitat characteristics were assumed to resemble present USS after 10 years. Future conditions for remaining UFO4 were discussed in Section 8.1.7.

9.1.8 UPLAND SCRUB-SHRUB (USS): Three acres of this cover type would be impacted. A net increase of 19 acres of USS was assumed after 10 years as a result of Freeboard regeneration. Habitat characteristics were assumed to resemble present USS after 10 years.

9.1.9 UPLAND FORB/GRASSLAND (UF/G): Five acres were predicted to be impacted, however because of forestry practices which are anticipated to create UF/G, no net change by TY 1 was assumed. Future conditions after TY 1 were discussed in Section 8.1.9.

9.1.10 RIVERINE (RIV): Eleven acres of RIV were projected lost to the project. Future conditions for remaining RIV in the study area were discussed in 8.1.10.

9.1.11 DISTURBED: Three acres of disturbed land were projected lost to the project.

9.1.12 FREEBOARD: A total of approximately 25 acres would be cleared as a Freeboard region. This region would regenerate into UF/G AND PSS cover types described above.

9.1.13 STRIPPED AUGMENTATION POOL: Seventeen acres of land were anticipated to fall into this category. Since the land will be stripped and also subjected to prolonged inundation followed by prolonged exposure, revegetation was projected to occur extremely slowly. For the purposes of this analysis, the area was assumed to remain unvegetated over the life of the project. This assumption may be extreme and hence impacts may be overstated.

9.1.14 CLEARED AUGMENTATION POOL: A total of 29 acres of the augmentation pool was projected to be cleared but not stripped. This land falls on the west side of the railroad bed and was predicted to revegetate into cover types described above.

9.1.15 CLEARED PERMANENT POOL: A total of 6 acres of the permanent pool was projected to be cleared but not stripped. This land falls on the west side of the railroad bed and was predicted to revegetate into cover types described above.

9.1.16 STRIPPED PERMANENT POOL: One hundred and three acres of land were projected to be stripped for the permanent pool. This area will result in a new cover type (Lacustrine) for Hodges Village. However, because of stripping, revegetation by rooted plants was predicted to occur very slowly. For the purposes of this analysis, the area was assumed to remain free of rooted plants over the life of the project. This assumption may be extreme and hence impacts may be overstated. Submerged aquatic plants were projected to colonize the permanent pool. A conservative estimate of 25% cover developing over 100 years was assumed.

9.2 ACREAGE PROJECTIONS

Based on assumptions listed in Section 9.1, the areas of each cover type and areas impacted by the project were projected for six target years; TY 0 (baseline), TY 1, TY 10, TY 35, TY 50, and TY 100. This information is presented in Table 9.1.

TABLE 9.1: COVER TYPE AREA (ACRES) AND DISTURBED AREA PREDICTIONS FOR FUTURE CONDITIONS WITH THE PROJECT WITHOUT MITIGATION.

Cover Type	Target Year					
	0	1	10	35	50	100
RIV	13	2	2	2	2	2
PEMM	18	7	18	42	42	42
PEMS	10	0	0	0	0	0
PSS						
Bog	17	8	8	8	8	8
Non-bog	45	3	6	6	6	6
PFO1	65	7	7	7	7	7
PFO4	23	23	23	23	23	23
UF/G	25	25	24	21	20	15
USS	17	14	36	36	36	36
UFO1	384	361	325	235	181	186
UFO4	77	67	104	197	252	252
DISTURBED	100	97	97	97	97	97
FREEBOARD	0	25	0	0	0	0
STRIPPED AUGMENTATION POOL	0	17	17	17	17	17
CLEARED AUGMENTATION POOL	0	29	20	0	0	0
STRIPPED PERMANENT POOL	0	103	103	103	103	103
CLEARED PERMANENT POOL	0	6	4	0	0	0
TOTAL	794	794	794	794	794	794

When an intermediate target year occurred prior to the end point of a predicted change in acreage, the intermediate year acreage was calculated assuming a linear rate of change.

9.3 SPECIES EVALUATIONS

Projected HSI values, acreage, Habitat Units (HU's), and the mean weighted HSI for the study site are presented in Appendix D. Following is a discussion of evaluation species based upon these data.

9.3.1 RED-BACKED VOLE: The ratio of Bog to Non-bog PSS changed as a result of project predictions. This in turn lowered the mean weighted HSI. Coupled with a projected decrease in total habitat because of both project and forestry management practices, the available HU's declined from 160 by approximately 60% (Table D-1, Appendix D).

9.3.2 MINK: It was projected that Mink habitat would be displaced by the project. The permanent pool was too large for Mink utilization based upon the HSI model. Mink will utilize upland habitat within 100 meters of the permanent pool, however because of disturbance during construction, this area was assigned an HSI equal to 0. The land increases to an HSI of 0.99 within 10 years based upon cover provided by vegetation. Also as the area west of the railroad develops into PEMM, a net increase in the mean weighted HSI results. The net result was a 72% drop in available HU's by TY 1 followed by a recovery which remained lower than baseline conditions of 389 HU's (Table D-2, Appendix D).

9.3.3 MUSKRAT: Of the three cover types Muskrat utilizes, one (PEMS) was lost and the other two were significantly reduced so that by TY 1 there was calculated a 73% loss in available HU's compared to 20 HU's at TY 0. As the marsh west of the railroad develops, recovery of HU's was projected to occur to a level almost identical to baseline conditions (Table D-3, Appendix D).

9.3.4 DUSKY SALAMANDER: The project was projected to impact significant areas of the salamanders habitat so that by TY 1 the available HU's were approximately 32% of baseline (106 HU's) conditions. It was not anticipated that the salamander would make use of the permanent pool because of its size and a lack of cover. Only slight recovery was projected (Table D-4, Appendix D).

9.3.5 WOOD FROG: Because of a reduction in habitat resulting from the project, a decline of 20% in available HU's was projected by TY 1 compared to the 373 HU's present under baseline conditions. The decline was predicted to continue because of forestry management impacts (Table D-5, Appendix D).

9.3.6 SNAPPING TURTLE: This turtle requires a permanent water regime. Under baseline conditions, only RIV and PEMM provided this resource. The project was projected to increase the amount of permanently flooded regions, however the HSI of the permanent pool was low because of a lack of aquatic vegetation. Nevertheless, after an initial project impact which reduced the available HU's by 76%, recovery was projected to result in an 82% increase over baseline (34 HU's) conditions by the end of the evaluation period (Table D-6, Appendix D).

9.3.7 GREEN HERON: The project was projected to reduce heron habitat so that available HU's dropped by 84% by TY 1 compared to the 128 HU's present under baseline conditions. Recovery was projected as a result of suitable habitat developing west of the railroad and also because part of the pool should be able to contribute resources. Water depth is critical and much of the pool area was too deep. A portion of the augmentation pool was projected for heron use although its HSI value was only 0.48 because of a lack of emergent vegetation. After 100 years, available HU's were still projected as lower than baseline conditions (Table D-7, Appendix D).

9.3.8 BLACK DUCK: Significant loss in Black Duck habitat was predicted which resulted in a decline in HU's of 87% by TY 1 compared to the 61 HU's present under baseline conditions. Recovery was projected as a result of suitable habitat developing west of the railroad. After 100 years, HU's were still calculated to be below baseline conditions (Table D-8, Appendix D).

9.3.9 WOOD DUCK: This species followed a similar pattern to Black Duck with an initial decline in HU's by TY 1 of 70% followed by recovery to below baseline (88 HU's) levels (Table D-9, Appendix D).

9.3.10 BROAD-WINGED HAWK: Habitat conditions were projected as optimal both before and after project implementation. A reduction in HU's was calculated as a result of habitat lost to the pools and marsh. Habitat Units dropped from 653 (TY 0) to 533 (TY 100) (Table D-10, Appendix D).

9.3.11 AMERICAN WOODCOCK: Calculations for this bird illustrated a gradual decline from 182 HU's over the time span of evaluation. Although the project is assumed to impact Woodcock habitat, little of its critical habitat (UF/G) would be impacted. Loss of HU's should be attributed primarily to natural maturation of cover types over time (Table D-11, Appendix D).

9.3.12 BELTED KINGFISHER: This bird dives into water after prey. A general lack of available water during most of the summer was responsible for a low mean weighted HSI on the study site. A significant increase in available resources was predicted with project implementation. Even with the assumption that the permanent and augmentation pools would take 10 years to develop moderate habitat, recovery was projected to be 213% over baseline (36 HU's) conditions by TY 100 (Table D-12, Appendix D). This increase should be thought of in terms of resource availability, not as a predicted increase in populations, because territorial behavior would restrict population levels to approximately present levels. Nevertheless, the increase has implications for other guild members.

9.3.13 DOWNY WOODPECKER: Project implementation has been calculated to reduce HU's by 19% by TY 1 (from an initial 418 HU's) as a result of lost habitat. The HU's were projected to continue to decline as a result of forestry practices (Table D-13, Appendix D).

9.3.14 YELLOW WARBLER: *Immediate project impacts were predicted* to reduce available shrub habitat by TY 1. Recovery was projected as a result of the Freeboard region developing into shrub cover types, but available HU's were still lower than baseline (39 HU's) conditions by TY 100 (Table D-14, Appendix D).

9.3.15 SWAMP SPARROW: Immediate project impacts were predicted to reduce available habitat by TY 1 resulting in a 76% decline in available HU's compared to the 119 HU's present under baseline conditions. Partial recovery was predicted as a result of marsh development west of the railroad (Table D-15, Appendix D).

10. FUTURE CONDITIONS WITH THE PROJECT WITH MITIGATION

10.1 MITIGATION PROGRAM

The following mitigation program was designed for implementation on Corps property at Hodges Village. Elements of the program were developed based on their mitigation value, practicality of implementation, and cost effectiveness. An attempt was made to integrate mitigation elements with existing programs. Conflicts with the goals of flood control, low-flow augmentation, and forestry management were avoided. Estimates of future HSI values were based upon realistic rather than idealistic assessments of potential future conditions.

10.1.1 STRIPPED AUGMENTATION POOL: Approximately 17 acres of land were identified which will have a high stress environment because they will be subject to both topsoil removal and alternate long term inundation followed by long term exposure. Exposure was also anticipated to reduce aesthetic values at Hodges Village. It is recommended that this area be deepened by excavation to the permanent pool level. Assuming a slope of 1:3 for stability, the area of land subject to exposure can be reduced to 7 acres. Such excavation would also enhance storage capacity.

10.1.2 IN KIND REPLACEMENT: The major impact identified was the replacement of wetland by the permanent and augmentation pools. Although the pools were projected to have some resource value to a number of the evaluation species, the net impact was a reduction in HU's for most species. One mitigation strategy was to develop new wetland resources for replacement of lost habitat. For a site to be developed into a wetland, it must be located where there is access to water. Water could theoretically be diverted from a stream, however the only stream large enough to supply the quantity of water needed would have been the French River. Low areas along the River were already wetlands, many of which were in the impact zone. It was not considered practical to enlarge these wetlands because of the excessive amount of excavation which would have been required.

A second source of water, groundwater, was considered. If upland areas were sufficiently close to the groundwater table, excavation could be used to create wetlands. Only one location at Hodges Village was found which could potentially be developed into a wetland because of its proximity to the water table. This site was west of the dam in a depression formed during glaciation. An analysis of the potential benefits of this action suggested that it would serve only to mitigate for approximately 3 % of the project impacts. Such a small return did not justify a recommendation for site development.

A third source of water which was considered was the permanent pool. If islands and peninsulas are built in an appropriate manner, they should be able to support wetland vegetation. It is this concept which is recommended and a description follows.

In order to place islands and peninsulas in the permanent pool, they must not interfere with either flood control objectives or low-flow augmentation objectives. Stated in another way, islands and peninsulas should not reduce storage capacity or degrade water quality. Since islands and peninsulas would be placed in the augmentation pool, loss of augmentation storage capacity would result. In order to avoid such loss, storage capacity must be increased elsewhere within the augmentation pool. There are three ways to increase augmentation pool storage capacity. (1) Enlarge the area of the augmentation pool by excavating adjacent land. There are several locations where this option could be utilized. (2) Deepen the augmentation pool around its periphery. An estimated 10 acres could be deepened to the level of the permanent pool. (3) Deepen the permanent pool and draw the augmentation pool down to a lower level. All three methods have advantages and disadvantages from a wildlife perspective. Details of augmentation storage capacity compensation will require a more accurate survey and topographic map than what is presently available. However calculations suggest that more than adequate compensation could be obtained. Storage compensation would have impacts which are not considered in this report other than to note that (based on available acres of habitat within the study area) impact conclusions which follow would be altered by less than 4%.

Depth of excavations are limited by the invert elevation at the dam. All excavations would be graded or channeled in a manner which would allow drainage to the dam. Costs should not be excessive since heavy equipment would be on site to remove topsoil in the stripping process and because the excavated material would not be transported out of the project area. The volume of islands and peninsulas is constrained by the amount of material excavated. Since excavation would not occur below the invert elevation, except for the purpose of removing organic topsoil, an upper limit is placed on the number and size of islands and peninsulas. Allowing for a safety margin for potential inaccuracies in the base map elevations, calculations suggest that reasonable storage capacity compensation for 25 acres of islands and peninsulas could be obtained. Figure 10.1 illustrates a potential arrangement of islands and peninsulas.

Water quality degradation can potentially occur because of nutrients leaching from topsoil. For this reason the Corps is planning to strip topsoil so that water will be in contact with relatively nutrient poor subsoil (sand and gravel). Islands and peninsulas must have topsoil in order for productive habitats to develop. The islands and peninsulas can be built from subsoil and their edges raised to a height to prevent overtopping by the augmentation pool. As a result, water stored in the augmentation and permanent pools would be in contact only with nutrient poor sand and gravel. However 0.5 to 1 foot of topsoil obtained from the stripping process should be placed over the interior of the islands and peninsulas.

A large number of island and peninsula designs can be envisioned. For the purposes of this analysis, peninsulas have the same basic design as islands except that they are longer and connected to land. However, they will function somewhat differently. Islands will reduce the threat of predation for nesting birds. Peninsulas will allow terrestrial animals such as mink to

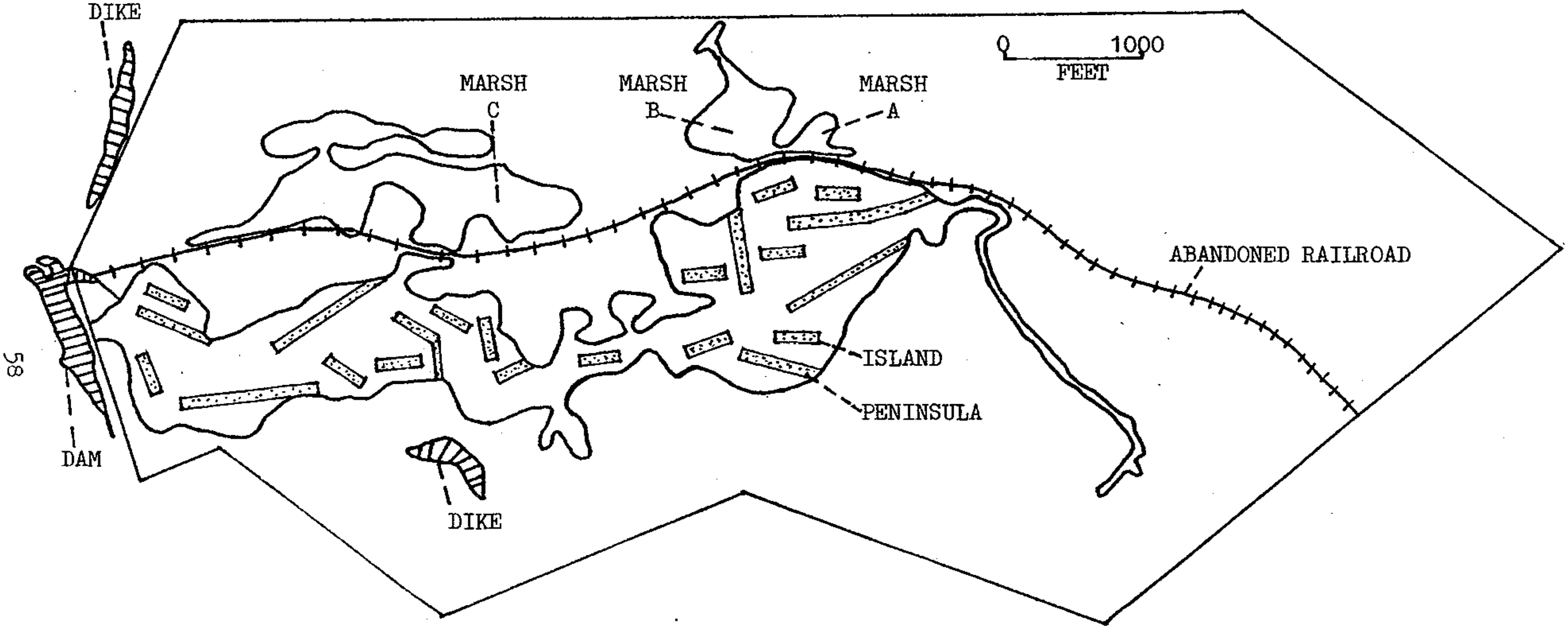

Figure 10.1. Arrangement of Islands and Peninsulas (stippled areas). Total of island areas equals 10 acres. Total of peninsula areas equals 15 acres.

gain access to the interior of the permanent pool. They would also allow fishing access.

Island design was predicated on maximizing evaluation species habitat parameters. Iterative designs were developed which successively optimized parameters. Trade-offs were made among different species parameters such that a balanced habitat would develop. A number of designs, each with advantages and disadvantages, were investigated. The design discussed here should not be thought of as a final design, however it serves the purpose of illustrating potential mitigation which can be achieved.

Figures 10.2 and 10.3 illustrate the design used in this analysis. The island was basically concave in shape such that the lowest elevation was below the permanent pool level. This insured the presence of open water in the island interior. The edge of the island was raised two feet above the augmentation pool to prevent overtopping by this pool. Water level in the island interior was expected to be controlled by the augmentation pool level. The island water table was assumed to be of major importance in controlling the type of vegetation which would develop. A planting program was assumed in order to insure appropriate vegetation development. The water table was assumed to be level and hence slope and topography were used to establish preplanned areas which would support different cover types. Forested cover types were not used in order to avoid potential problems with debris and maintenance. Two cover types, PSS and PEMM, were assumed to be planted in a zonation pattern. The highest elevations would support a shrub wetland, followed by a band of short herbaceous plants followed by a band of tall emergents (Cattails) and followed by open water. In order to maximize the edge index, topography was varied as indicated in Figures 10.2 and 10.3. A number of hummocks were situated in the open water area to increase edge index. These hummocks were assumed to be planted in Buttonbush which will produce branches overhanging the water for wildlife cover.

The planting program should utilize a variety of species to increase diversity. Appropriate shrubs include Buttonbush, Withe-rod (*Viburnum cassinoides*), Arrow-Wood, Highbush Blueberry, Swamp Dogwood, and Speckled Alder. Appropriate herbaceous species include Cattail, Pickerelweed (*Pontederia cordata*), Spike Rush, Tussock Sedge, Ferns, and hydrophytic grasses. Aside from vegetation, large rocks or concrete blocks should be scattered around to provide refuge sites for salamanders and loafing sites for ducks.

Islands and peninsulas should be annually inspected and maintained. Major deviations in vegetation development should not be allowed. The structures should, in general, require low maintenance, however the first 5 years of development will be critical and therefore careful attention is recommended.

10.1.3 HABITAT IMPROVEMENT: A number of opportunities existed to increase habitat quality of post construction areas. Reclamation of 9 acres of disturbed areas (gravel pits) were assumed in this analysis. Only Corps land was available for reclamation. Since the Corps plans to remove topsoil from the reservoir site (more

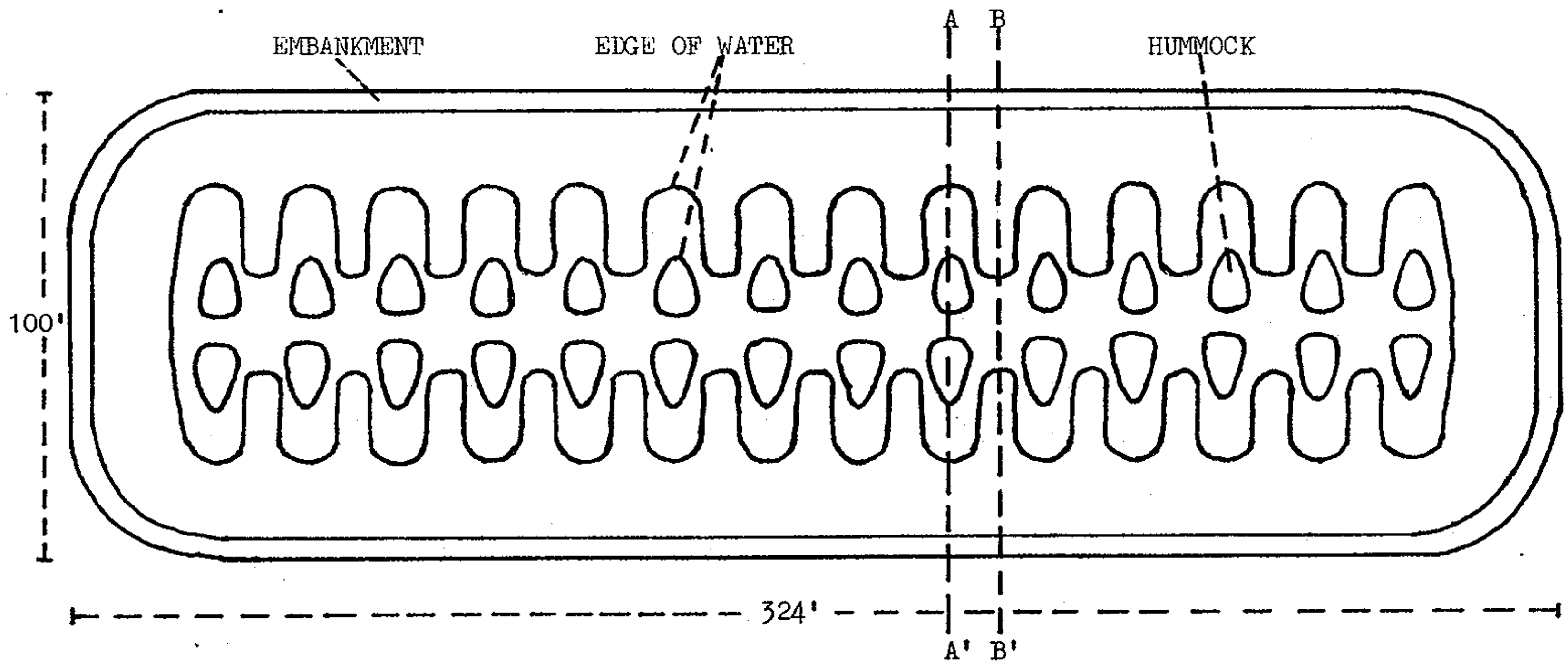

Figure 10.2. Plane view of Island. An embankment, 5 feet wide at crest, encircles the Island and rises two feet above the Augmentation Pool. The Island slopes downward inside the embankment as depicted by AA' and BB' in Figure 10.3. The area of standing water in the Island interior will vary with pool height and is shown here at Permanent Pool level. Hummocks, planted in Buttonbush, were placed in the Island interior to increase edge and provide woody cover within the standing water area.

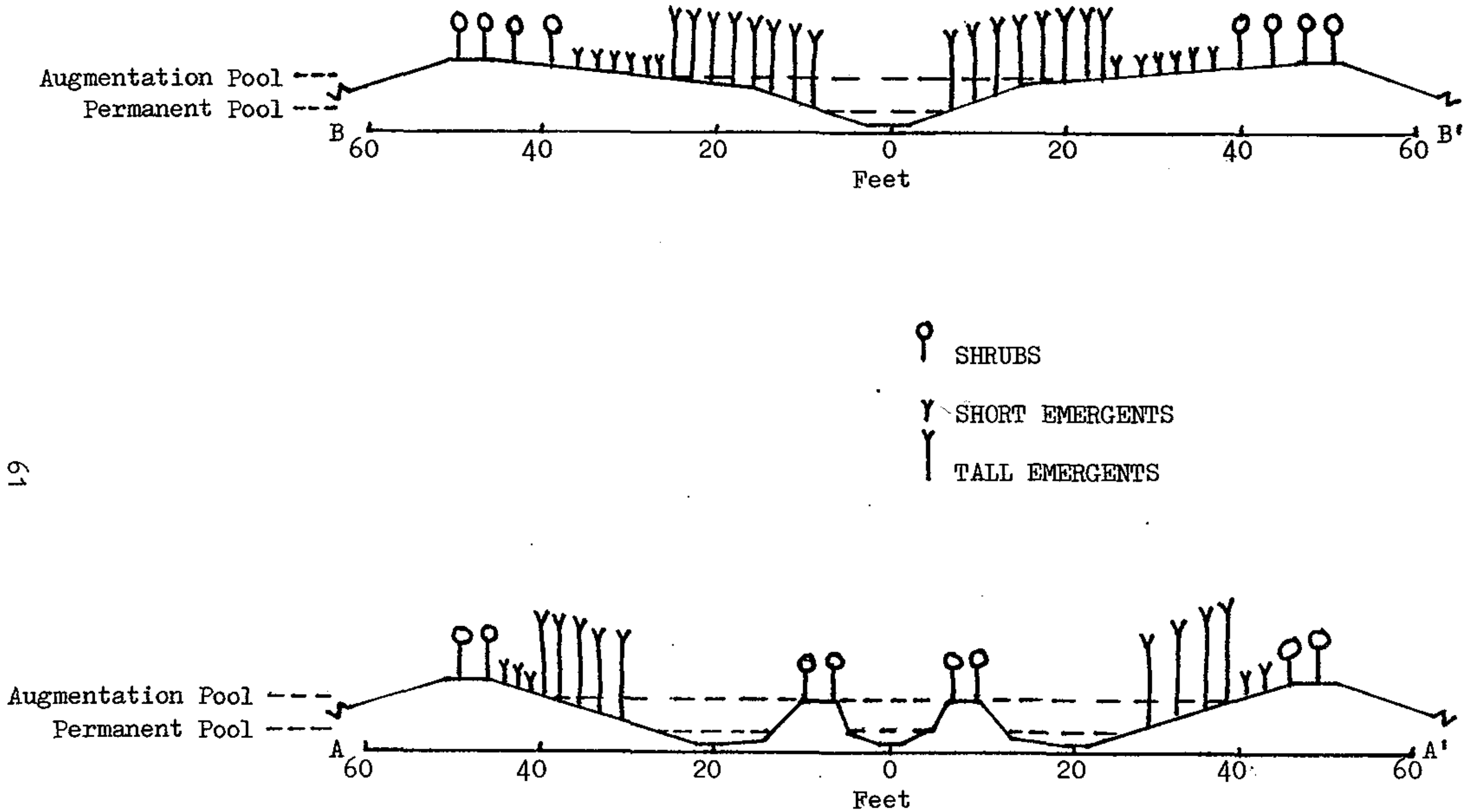

Figure 10.3. Cross sections (see Figure 10.2 for position of AA' and BB') of Island. Top soil extends inward from the crest of the embankment. Habitat characteristics were projected based on vegetative cover as shown and depth of water in the Island interior.

than what could be used for islands and peninsulas), some of this material could be placed over the disturbed areas and seeded to control erosion. The areas were assumed to progress through succession to a forested state.

The permanent and augmentation pools west of the railroad were projected to develop into PEMM. Figures 10.1 and 10.4 illustrate these areas. The northern marsh (marsh A) could be improved by (1) increasing the edge index and (2) increasing the area which is less than 18 inches in water depth (for ducks and wading birds). It was assumed that 5 foot wide ditches will be dredged radiating outward from the center of the marsh. Dredged material would be placed along the edge of the ditches thus reducing water depth and allowing the establishment of Cattail. The Cattail will form edge for duck broods and other wildlife. A total of 800 feet of ditch was considered desirable.

Marsh B (Figures 10.1 and 10.4) was also projected to be too deep and the edge index too low for optimum habitat. Because of the size and depth of the area, a simple ditching program was not projected to be adequate. Construction of islands was decided to be the best alternative. The islands should be different from those discussed in Section 10.1.2. Islands previously discussed were based on the premise that areas of productive habitat could be created which were isolated from the surrounding pool in order to prevent water quality degradation. Marsh B will not be stripped and hence a productive habitat was projected to return over time. Mitigation in Marsh B should be integrated with this productive habitat. Therefore simple enlarged hummocks covered by topsoil are recommended. It was assumed that the hummocks would gradually rise from the marsh floor to an elevation 1 foot above the augmentation pool. A zone in the island middle (5 feet wide) would extend above pool level. A zone in the island middle (20 feet wide) would become established in Cattail. Island width would be 50 feet and a combined length of all islands would equal 750 feet. A portion of the augmentation pool in Marsh B should be excavated to enlarge the permanent pool and replace lost storage capacity resulting from the islands.

Marsh C (Figures 10.1 and 10.4) posed a different problem. The permanent pool was not projected to reach Marsh C and hence habitat quality was reduced because of a lack of permanent water. The edge index was also low. Creation of permanent ponds is recommended. It was assumed that the dredged ponds would be asymmetrical in shape in order to increase edge between open water and vegetated areas. Total area of the pond was assumed to equal 5.5 acres.

Large areas of wetland on Corps land but north of the study site were observed. A habitat improvement scheme was considered and subsequently abandoned. These wetlands had many characteristics which were ideal for wildlife. An attempt to improve them would do little to enhance wildlife values.

The final element of the mitigation program dealt with forestry management on Corps land. The H.E.P. analysis revealed a close interrelationship between wetlands and uplands at Hodges

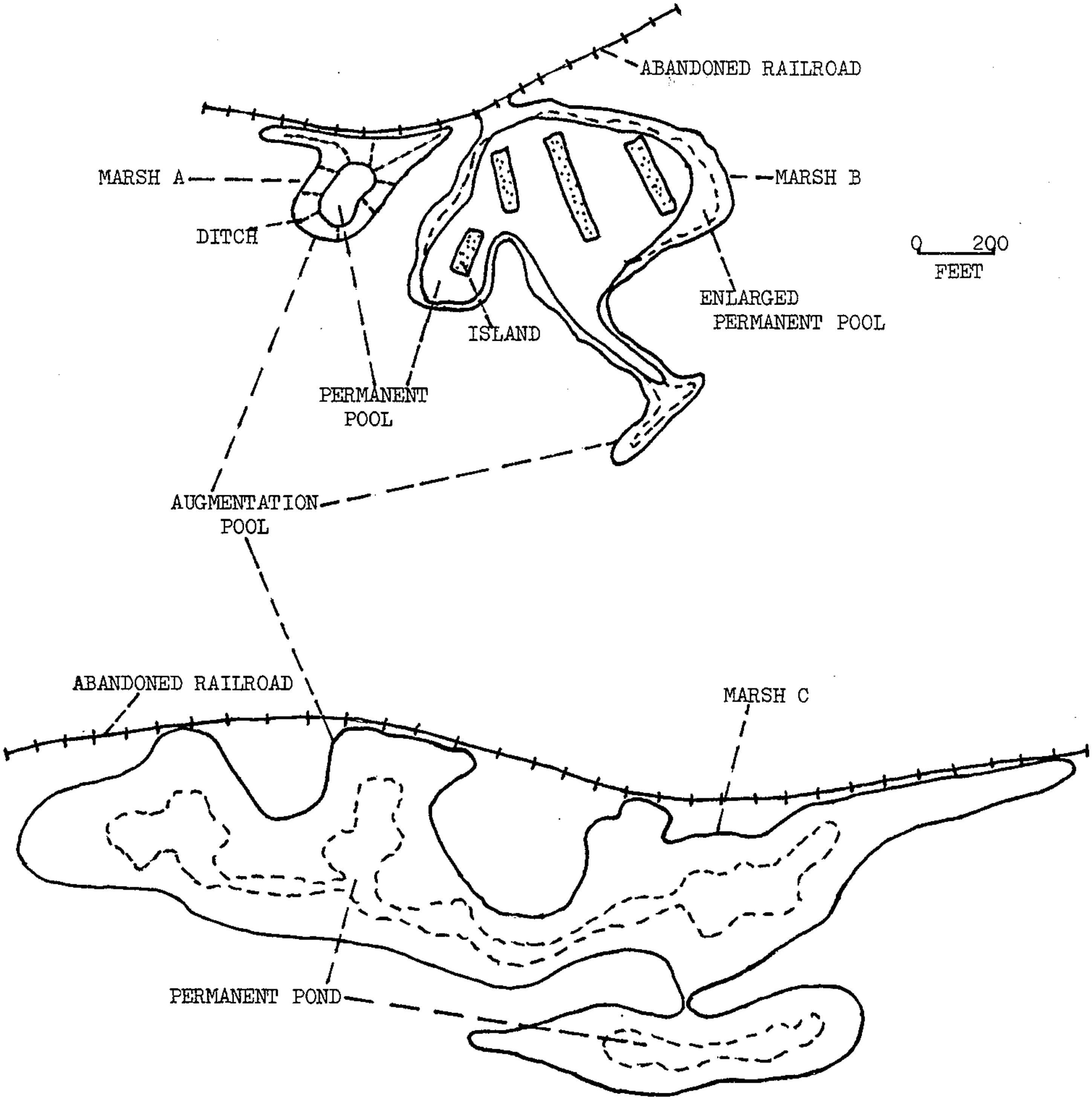

Figure 10.4. Mitigation measures for Marshes A, B and C (see Figure 10.1 for locations of marshes within Study Area).

Village. Many of the species which utilized deciduous forested and shrub wetlands also made use of deciduous forested and shrub uplands. Since the forestry management program was anticipated to reduce total acreage of deciduous forested uplands, a relationship between the proposed project and the management plan impacts was observed. This should not be construed as a condemnation of the forestry management program, but rather as an incompatibility between the proposed project and the program. To remove this incompatibility, a weeding program is recommended. Selective cutting is planned which will result in an increase in abundance of uncut plant species and which accounts for the conversion of pine areas to oak and oak to pine. An improved balance of these two cover types was assumed by re-entering logged areas of deciduous forest, removing evergreens and thus maintaining a deciduous forest. Not all areas are recommended for this action. It was assumed that 90 acres which would be expected to convert to pine would be maintained in oak forest.

Other forestry management techniques were assumed which improved expected future habitats. The amount of UF/G was determined to be limiting for American Woodcock despite the planned addition of this cover type mentioned in Section 8.1.1. An increase of this cover type by small clear cuts was assumed as a mitigation strategy. The total amount of UF/G varied over time as a consequence of varying amounts of other Woodcock habitat. The desired amounts are presented in Table 10.1 in Section 10.3. The conditions in UF04 were projected to be limiting for Downy Woodpecker because of high basal area and low snag density. It was assumed that thinning and weeding operations could be carried out to reduce basal area and girdling to increase snag density in this cover type. *An increase in the HSI for UF04 to a level* equivalent to UF01 seemed a reasonable goal. Finally, an increase in debris cover to 20 - 25% by leaving weeded and thinned trees on the ground was assumed for improved Vole habitat.

10.2 ASSUMPTIONS

Assumptions described in Section 9.1 were used except for expected improvements because of the mitigation program discussed above. Detailed assumptions used to calculate HSI values will be brought out in Section 10.4, SPECIES EVALUATIONS.

10.3 ACREAGE PROJECTIONS

The areas of each cover type , impact areas, and special mitigation areas were projected for six target years; TY 0 (baseline), TY 1, TY 10, TY 35, TY 50, and TY 100. Although special mitigation areas were predicted to develop into existing cover types, they are treated separately so that their contributions towards mitigation may be evaluated. This information is presented in Table 10.1.

TABLE 10.1: COVER TYPE AREA (ACRES), DISTURBED AREA, AND SPECIAL MITIGATION AREA PREDICTIONS WITH THE PROJECT WITH MITIGATION.

Cover Type	Target Year 0	1	10	35	50	100
RIV	13	2	2	2	2	2
PEMM	18	7	7	7	7	7
PEMS	10	0	0	0	0	0
PSS						
Bog	17	8	8	8	8	8
Non-bog	45	3	6	6	6	6
PFO1	65	7	7	7	7	7
PFO4	23	23	23	23	23	23
UF/G	25	25	40	30	30	30
USS	17	14	45	36	36	36
UFO1	384	361	329	296	271	271
UFO4	77	67	84	136	161	161
DISTURBED	100	97	88	88	88	88
FREEBOARD	0	25	0	0	0	0
STRIPPED AUGMENTATION POOL	0	7	7	7	7	7
STRIPPED PERMANENT POOL	0	88	88	88	88	88
MARSHES A, B & C	0	35	35	35	35	35
ISLANDS	0	10	10	10	10	10
PENINSULAS	0	15	15	15	15	15
TOTAL	794	794	794	794	794	794

When an intermediate target year occurred prior to the end point of a predicted change in acreage, the intermediate year acreage was calculated assuming a linear rate of change.

10.4 SPECIES EVALUATIONS

Projected HSI values, acreage, Habitat Units (HU's), and the mean weighted HSI for the study site are presented in Appendix E. Following is a discussion of evaluation species based upon these data.

10.4.1 RED-BACKED VOLE: The ratio and amount of useable cover types were altered by the mitigation program. A third of the islands and peninsulas were estimated to develop into non-bog shrub wetlands. Voles quickly colonize wetlands as flood waters recede, however Islands will be difficult to colonize. Therefore Island PSS is not included as potential Vole habitat. Five acres of Peninsula habitat were included and the HSI was assumed to reach baseline non-bog conditions within 10 years. Clear cutting to increase Woodcock habitat was assumed. Clear cuts were predicted to be maximum by TY 1 and then to decline. Areas which will not be maintained after TY 1 as UF/G were assumed to succeed to shrub land. Freeboard was also assumed to develop into shrub land. UFO1 was predicted to be maintained in higher abundance compared to conditions without mitigation. The HSI value for UFO1 was projected to increase because of debris left by the forestry weeding program . Recovery from the project was calculated to result in only a slight decrease in available HU's compared to baseline (160 HU's) conditions (Table E-1, Appendix E).

10.4.2 MINK: Mink habitat was calculated to increase in area compared to conditions without mitigation because of the presence of islands and peninsulas. The HSI values for islands and peninsulas were calculated by assuming vegetation cover development similar to baseline conditions in equivalent cover types. The peninsulas subdivided the permanent pool into relatively small units which were assumed to be utilized by Mink. The net result was an initial decline in available HU's by TY 1 followed by a recovery which increased HU's to values slightly higher than baseline (389 HU's) conditions (Table E-2, Appendix E).

10.4.3 MUSKRAT: Muskrat habitat was projected to improve as a result of mitigation in Marshes A, B, and C. This was primarily a result of proposed dredging in Marsh C to establish a permanent water regime. Islands and peninsulas were assumed to function as Muskrat habitat because of their herbaceous wetlands and Cattail stands. After weighting for island and peninsula PSS (which reduced the HSI), these areas were assumed to reach an HSI value of .45 within 10 years. The net result was a significant enlargement of available Muskrat habitat. After dropping in TY 1, HU's recovered to over twice the baseline (20 HU's) value (Table E-3, Appendix E).

10.4.4 DUSKY SALAMANDER: The mitigation program only produced a small increase in salamander habitat as a result of island and peninsula PSS and the forestry recommendations. The net result was still a significant loss of HU's for this species. Habitat Units declined from 106 (TY 0) to 45 (TY 100) (Table E-4, Appendix E).

10.4.5 WOOD FROG: The mitigation program cushioned frog impacts as a result of forestry recommendations which would maintain UFO1 habitat. By TY 100 available HU's (226) were projected to be slightly higher than without the project but still below 373 HU's calculated for baseline conditions (Table E-5, Appendix E).

10.4.6 SNAPPING TURTLE: The mitigation program reduced the quantity of habitat compared to "project without mitigation" predictions. However a large increase in available HU's over "without the project" conditions was still projected (Table E-6, Appendix E).

10.4.7 GREEN HERON: Improvements in Marshes A, B, and C resulted in a small increase in habitat quality because of the mitigation program. The creation of islands and peninsulas were most important in improving available HU's compared to "without mitigation" conditions. However a net loss in HU's was still projected when compared to "without project" conditions. Habitat Units were projected to decline from 128 (TY 0) to 84 (TY 100) with mitigation (Table E-7, Appendix E).

10.4.8 BLACK DUCK: Because of the creation of islands and peninsulas, the total amount of habitat was increased compared with "without mitigation" conditions. HSI values for these areas were based upon projected water depth and edge index. Peninsulas, because of a higher edge index, produced a slightly higher HSI value than islands. In both cases a conservative approach was taken by excluding edge on the outer perimeters. This assumes that duck will not utilize the permanent pool. Marshes A, B, and C were improved in quality by the mitigation program. The net result was higher HU values after TY 10 compared with "without mitigation" conditions, however values remained below "without project" conditions. Habitat Units were projected to decline from 61 (TY 0) to 44 (TY 100) with mitigation (Table E-8, Appendix E).

10.4.9 WOOD DUCK: Brood habitat was limiting for this bird in all future conditions. The mitigation program resulted in improved brood habitat in Marshes A, B, and C. Islands and peninsulas provided additional habitat. Brood cover on islands and peninsulas will vary with pool level. Assuming average summer conditions, a moderate suitability index of .67 was calculated. The net result was an increase in HU's compared with "without mitigation" conditions and a net decrease compared with "without project" conditions. Habitat Units were projected to decline from 88 (TY 0) to 76 (TY 100) with mitigation (Table E-9, Appendix E).

10.4.10 BROAD-WINGED HAWK: As with predictions for "without project" and "without mitigation", the "with mitigation" projections indicated optimum habitat. The total amount of habitat was improved compared to "without mitigation" projections but was still less than "without project" projections. The net result was a gain in HU's with mitigation but not enough to totally offset project impacts. Habitat Units were projected to decline from 653 (TY 0) to 550 (TY 100) with mitigation (Table E-10, Appendix E).

10.4.11 AMERICAN WOODCOCK: The mitigation program gave excellent results with this species. Available UF/G cover was limiting. By increasing this cover type through small clear cuts and also by maintaining a larger acreage in UF01, projected HU's were well above either "without project" or "without mitigation" conditions (Table E-11, Appendix E).

10.4.12 BELTED KINGFISHER: Conditions for this species were improved because of its projected utilization of the augmentation and permanent pools. Since the mitigation program reduces the size of these pools, the increase in HU's was not quite as high as in "without mitigation" conditions but still well above baseline conditions after TY 1. Habitat Units were projected to increase from 36 (TY 0) to 109 (TY 100) with mitigation (Table E-12, Appendix E).

10.4.13 DOWNY WOODPECKER: The mitigation program resulted in a greater acreage of UF01 over time compared to "without project" conditions. Also the proposed forestry management scheme resulted in improving habitat in UF04 because of a decrease in basal area from thinning and an increase in snag density from girdling. An HSI value equivalent to UF01 was assumed attainable. The net result was an increase in available HU's compared to "without mitigation" conditions. Habitat Units were projected to decrease from 418 (TY 0) to 364 (TY 100) with mitigation (Table E-13, Appendix E).

10.4.14 YELLOW WARBLER: Islands and peninsulas provided additional habitat for this bird. HSI values were predicated on an equivalent shrub canopy closure to baseline PSS but higher average height because of Speckled Alder plantings. An increase in USS was projected in TY 10 compared to "without mitigation" conditions because of clear cut areas which would be allowed to follow normal successional patterns. The net result was an increase in HU's compared to "without mitigation" conditions but not enough to totally compensate for project impacts. Habitat Units were projected to decrease from 39 (TY 0) to 30 (TY 100) with mitigation (Table E-14, Appendix E).

10.4.15 SWAMP SPARROW: Islands and peninsulas provided additional habitat. HSI values were predicated on an equivalent shrub canopy closure to baseline PSS but higher average height because of Speckled Alder plantings. The net result was an increase in HU's compared to "without mitigation" conditions but not enough to totally compensate for project impacts. Habitat Units were projected to decrease from 119 (TY 0) to 78 (TY 100) with mitigation (Table E-15, Appendix E).

11. AVERAGE ANNUAL HABITAT UNIT ANALYSIS

Because of variations in Habitat Units over time it is difficult to compare the three future conditions. Habitat Units for a species may initially drop and then recover. Does this recovery compensate for the initial loss? By calculating Average Annual Habitat Units (AAHU's) this question may be answered. AAHU's are in effect the area under the HU vs. time curve divided by the time span. Table 11.1 illustrates AAHU's for all evaluation species and the net change from future conditions without the project.

TABLE 11.1: AVERAGE ANNUAL HABITAT UNITS OVER 100 YEARS.

EVALUATION SPECIES	WITHOUT PROJECT (A)	PROJECT WITHOUT MITIGATION (B)	NET CHANGE (B-A)	PROJECT WITH MITIGATION (C)	NET CHANGE (C-A)
RED-BACKED VOLE	123	74	-49	147	+24
MINK	391	292	-99	381	-10
MUSKRAT	22	16	-6	37	+15
DUSKY SALAMANDER	114	42	-72	43	-71
WOOD FROG	257	191	-66	241	-16
SNAPPING TURTLE	34	39	+5	70	+36
GREEN HERON	128	57	-71	77	-51
BLACK DUCK	60	22	-38	39	-21
WOOD DUCK	91	48	-43	72	-19
BROAD-WINGED HAWK	653	532	-121	549	-104
AMERICAN WOODCOCK	179	145	-34	230	+51
BELTED KINGFISHER	36	104	+68	99	+63
DOWNY WOODPECKER	369	297	-72	355	-14
YELLOW WARBLER	40	23	-17	31	-9
SWAMP SPARROW	119	54	-65	72	-47
TOTAL	2616	1936	-680	2443	-173

If the project is implemented without mitigation, there was calculated a loss of 680 AAHU's. Two species, Snapping Turtle and Belted Kingfisher, were anticipated to increase while all other species would decrease. This represents a decrease of 26% from the predicted conditions without the project. (It is interesting to note that the impact zone of 180 acres represents 26% of the total available habitat, excluding disturbed areas such as gravel pits, in the study area.) If the project is implemented with mitigation, there was calculated a loss of 173 AAHU's. Five species, Red-Backed Vole, Muskrat, Snapping Turtle, American Woodcock, and Belted Kingfisher, were anticipated to increase while the other ten would decrease. The projected loss represents a decrease of 7% from the predicted conditions without the project. The mitigation program recovers approximately 75% of the projected loss without mitigation. Two points should be recognized. (1) An attempt was made to use conservative estimates of habitat conditions and if these assumptions are in error, the impact may have been overstated. (2) The mitigation program establishes goals. Although an attempt was made to make the goals realistic, these goals may not be totally achieved. Thus impacts may have been understated. If an error of + or - 25% is assumed, then the mitigation program may recover between 68% and 81% of projected loss without mitigation.

12. GUILD GENERALIZATIONS

The H.E.P. analysis indicated a decline of 26% in evaluation species AAHU's without mitigation and a decline of 7% with mitigation. Since these species represent a large number of the guilds at Hodges Village, a similar pattern was anticipated for the majority of wildlife. The changes were not uniform among guilds. Species utilizing subsurface areas were not anticipated to be severely impacted with appropriate mitigation. Of the three evaluation species which make use of banks (Mink, Muskrat, and Belted Kingfisher), increases in AAHU's for two them were predicted. Muskrats were anticipated to utilize island and peninsula banks. Belted Kingfisher reproductive areas were not limiting. Many other species which dig dens do so in upland habitats which were not predicted to be strongly impacted.

A decrease in vegetated land was projected. The mitigation program resulted in re-establishment of vegetation partially mitigating this impact. Except for nine acres of disturbed area which was assumed to be reclaimed and to develop into forest, the mitigation program was assumed to establish shrub and herbaceous cover types. Therefore greatest loss (with mitigation) was projected for tree canopy resources (especially PFO1). Of the eleven evaluation species which were calculated to loose AAHU's, six of them (Green Heron, Wood Duck, Broad-Winged Hawk, Downy Woodpecker, Yellow Warbler, and Swamp Sparrow) utilized tree canopy resources and they represented 67% of the loss of all negatively impacted evaluation species (based on "with mitigation" conditions).

Maintaining a higher proportion of UFO1 improved projected conditions for two of the six species (Wood Duck and Downy Woodpecker). The guilding analysis (Appendix A) indicated that seventeen species utilized the tree canopy of PFO1 for reproduction and that eleven of these also utilized UFO1. It is logical to assume that maintaining a larger area of UFO1 may, to a degree, compensate for loss of PFO1 for these eleven species. However, not all eleven species could be expected to benefit from a higher proportion of UFO1 produced by mitigation. This is because some of the eleven species also would utilize UFO4. Any benefit from a larger area of UFO1 would be offset by a smaller acerage of UFO4. Only five of these species (Gray Squirrel, Eastern Kingbird, Least Flycatcher, Red-Eyed Vireo, and Northern Oriole) were expected to benefit. Hence partial compensation for a slightly higher proportion of wildlife utilizing this resource (5 out of 17) as the proportion of evaluation species (2 out of 6) recieving benefit was estimated.

Shrub layer resources which were in PFO1 and PSS were predicted to be most heavily impacted (relative to all shrub resources available at Hodges Village). Two of the fifteen evaluation species (20%) utilized these resources for reproduction. Eleven of the seventy four candidate evaluation species (15%) utilized shrub resources in these cover types for reproduction (see Appendix A). Therefore the H.E.P. analysis may slightly exagerate impacts relative to these guilds. The mitigation program should partially compensate species in these guilds because of PSS created on islands and peninsulas and because of shrub cover alterations resulting from forestry practices.

Surface and aquatic resources which were available in wetlands and the French River were predicted to be most heavily impacted (relative to all such resources available at Hodges Village). Eight of the fifteen evaluation species (53%) utilized these resources for reproduction. Thirty nine of the seventy four candidate evaluation species (53%) utilized similar resources (see Appendix A). Therefore the H.E.P. analysis should fairly represent impacts relative to these guilds. The mitigation program should partially compensate for lost surface resources and enhance aquatic resources.

The above discussion suggests that the H.E.P. analysis should be indicative of impacts to a braod spectrum of wildlife at Hodges Village. This is because the evaluation species make use of all impacted resources; and because the proportion of evaluation species utilizing any particular resource is roughly equivalent to the proportion of candidate species making use of the same resource.

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APPENDIX A
COVER TYPE GUILDS

TABLE A-1: REPRODUCTIVE GUILDS FOR PALUSTRINE DECIDUOUS FORESTED WETLAND.

LOCATIONAL DESCRIPTOR	REPRODUCTIVE GUILD
Tree Layer	
Live Vegetation	Gray Squirrel, Wood Duck, Tree Swallow, Eastern Kingbird, Least Flycatcher, Eastern Wood Pewee, American Robin, Red-Eyed Vireo, Yellow Warbler, Northern Oriole, Common Grackle, Green Heron, Broad-Winged Hawk
Dead Wood	Tree Swallow, Common Flicker, Downy Woodpecker, Black-capped Chickadee
Shrub Layer	Gray Catbird, American Robin, Veery, Yellow Warbler, Common Yellowthroat, Rufous-Sided Towhee, Song Sparrow, Red-Winged Blackbird, Common Grackle, Green Heron, Swamp Sparrow
Herbaceous Layer, Surface, and/or Water	Red-Backed Vole, Deer Mouse, White-Footed Mouse, Masked Shrew, Short-Tailed Shrew, Long-Tailed Weasel, Raccoon, Eastern Newt, Dusky Salamander, Red-Backed Salamander, Spring Peeper, Wood Frog, Bullfrog, American Toad, Spotted Turtle, Eastern Box Turtle, Snapping Turtle, Milk Snake, Common Garter Snake, Water Snake, Black Duck, Mallard, Blue-Winged Warbler, Black-and-White Warbler, American Woodcock, Veery, Common Yellowthroat, Rufous-Sided Towhee, Song Sparrow, Red-Winged Blackbird, Swamp Sparrow
Subsurface	
Flat Ground	None
Bank	Belted Kingfisher

TABLE A-2: REPRODUCTIVE GUILDS FOR PALUSTRINE NEEDLE-LEAVED EVERGREEN FORESTED WETLAND.

LOCATIONAL DESCRIPTOR	REPRODUCTIVE GUILD
Tree Layer	
Live Vegetation	Eastern Wood Pewee, Blue Jay, American Robin, Common Grackle, Green Heron, Broad-Winged Hawk
Dead Wood	Common Flicker, Downy Woodpecker, Black-Capped Chickadee
Shrub	Blue Jay, American Robin, Veery, Song Sparrow, Common Grackle, Green Heron, Swamp Sparrow
Herbaceous Layer, Surface, and/or water	Deer Mouse, White-Footed Mouse, Masked Shrew, Short-Tailed Shrew, Long-Tailed Weasel, Raccoon, Eastern Newt, Dusky Salamander, Red-Backed Salamander, Spring Peeper, American Toad, Spotted Turtle, Eastern Box Turtle, Milk Snake, Common Garter Snake, Veery, Song Sparrow, Swamp Sparrow
Subsurface	
Flat Ground	None
Bank	Belted Kingfisher

TABLE A-3: REPRODUCTIVE GUILDS FOR PALUSTRINE SCRUB-SHRUB WETLAND.

LOCATIONAL DESCRIPTOR	REPRODUCTIVE GUILD
Shrub	Gray Catbird, American Robin, Yellow Warbler, Common Yellowthroat, Song Sparrow, Red-Winged Blackbird, Common Grackle, Green Heron, Swamp Sparrow
Herbaceous Layer, Surface, and/or Water	Red-Backed Vole, Deer Mouse, White-Footed Mouse, Masked Shrew, Short-Tailed Shrew, Eastern Newt, Dusky Salamander, Spring Peeper, American Toad, Bullfrog, Spotted Turtle, Eastern Box Turtle, Snapping Turtle, Common Garter Snake, Black Duck, Mallard, Common Yellowthroat, Song Sparrow, Swamp Sparrow, Red-Winged Blackbird
Subsurface	
Flat Ground	None
Bank	Belted Kingfisher

TABLE A-4: REPRODUCTIVE GUILDS FOR PALUSTRINE EMERGENT WETLAND.

LOCATIONAL DESCRIPTOR	REPRODUCTIVE GUILD
Herbaceous Layer, Surface, and/or Water	Muskrat, Eastern Newt, American Toad, Bullfrog, Spotted Turtle, Eastern Box Turtle, Snapping Turtle, Water Snake, Common Garter Snake, Black Duck, Mallard, Song Sparrow, Swamp Sparrow, Red-Winged Blackbird, Common Grackle, Common Yellowthroat
Subsurface	
Flat Ground	None
Bank	Belted Kingfisher

TABLE A-5: REPRODUCTIVE GUILDS FOR UPLAND DECIDUOUS FOREST.

LOCATIONAL DESCRIPTOR	REPRODUCTIVE GUILD
Tree Layer	
Live Vegetation	Gray Squirrel, Eastern Kingbird, Least Flycatcher, Eastern Wood Pewee, Blue Jay, American Robin, Wood Thrush, Red-Eyed Vireo, Northern Oriole, Red-Tailed Hawk, Broad-Winged Hawk, Great Horned Owl
Dead Wood	Common flicker, Downy Woodpecker, Black-Capped Chickadee
Shrub	American Robin, Wood Thrush, Rufous-Sided Towhee, Song Sparrow, Yellow Warbler
Herbaceous Layer, Surface	Red-Backed Vole, Deer Mouse, White-Footed Mouse, Short-Tailed Shrew, White-Tailed Deer, Long-Tailed Weasel, Raccoon, Eastern Cottontail, American Toad, Eastern Box Turtle, Snapping Turtle, Racer, Milk Snake, Black Duck, Blue-Winged Warbler, Black and White Warbler, Ovenbird, Rufous-Sided Towhee, Song Sparrow
Subsurface	
Flat Ground	Eastern Chipmunk, Long-Tailed Weasel, Red Fox
Bank	Belted Kingfisher

TABLE A-6: REPRODUCTIVE GUILDS FOR UPLAND NEEDLE-LEAVED EVERGREEN FOREST.

LOCATIONAL DESCRIPTOR	REPRODUCTIVE GUILD
Tree Layer	
Live Vegetation	Red Squirrel, Eastern Wood Pewee, Blue Jay, American Robin, Chipping Sparrow, Broad-Winged Hawk, Great Horned Owl
Dead Wood	Common Flicker, Downy Woodpecker, Black-capped Chickadee
Shrub	American Robin, Rufous-Sided Towhee
Herbaceous Layer, Surface	Deer Mouse, White-Footed Mouse, Short-Tailed Shrew, Eastern Cottontail, White-Tailed Deer, Long-Tailed Weasel, American Toad, Eastern Box Turtle, Racer, Milk Snake, Ovenbird, Rufous-Sided Towhee
Subsurface	
Flat Ground	Long-Tailed Weasel, Red Fox
Bank	Belted Kingfisher

TABLE A-7: REPRODUCTIVE GUILDS FOR UPLAND SCRUB-SHRUB.

LOCATIONAL DESCRIPTOR	REPRODUCTIVE GUILD
Shrub	Rufous-Sided Towhee, Song Sparrow, Yellow Warbler
Herbaceous Layer, Surface	Red-Backed Vole, Deer Mouse, White-Footed Mouse, Short-Tailed Shrew, Eastern Cottontail, White-Tailed Deer, Long-Tailed Weasel, American Toad, Racer, Blue-Winged Warbler, Common Yellowthroat, Rufous-Sided Towhee, Song Sparrow
Subsurface	
Flat Ground	Eastern Chipmunk, Long-Tailed Weasel, Red Fox
Bank	Belted Kingfisher

TABLE A-8: REPRODUCTIVE GUILDS FOR UPLAND FORB/GRASSLAND.

LOCATIONAL DESCRIPTOR	REPRODUCTIVE GUILD
Herbaceous Layer, Surface	Deer Mouse, White-Footed Mouse, Eastern Cottontail, White-Tailed Deer, American Toad, Racer, Black Duck, Song Sparrow, Killdeer, American Woodcock
Subsurface	
Flat Ground	Red Fox
Bank	Belted Kingfisher

TABLE A-9: REPRODUCTIVE GUILDS FOR RIVERINE SYSTEM.

LOCATIONAL DESCRIPTOR	REPRODUCTIVE GUILD
Aquatic	Beaver, Eastern Newt, Dusky Salamander, Gray Treefrog, Green Frog, Pickerel Frog, Northern Leopard Frog, Wood Frog, Bullfrog
Bank	Mink, River Otter, Muskrat, Beaver, Spotted Sandpiper, Belted Kingfisher

TABLE A-10: FEEDING GUILDS FOR PALUSTRINE DECIDUOUS FORESTED WETLAND.

DESCRIPTOR	FEEDING GUILD
Vegetated Layers	
Vertebrate Carnivore	None
Invertebrate Carnivore	Gray Treefrog, Tree Swallow, Barn Swallow, Downy Woodpecker, Eastern Kingbird, Least Flycatcher, Eastern Wood Pewee, Red-Eyed Vireo, Black-and-White Warbler, Yellow Warbler
Omnivore	Black-Capped Chickadee, Blue Jay, American Robin, Northern Oriole, Song Sparrow, Swamp Sparrow
Herbivore	Gray Squirrel
Surface and/or Water	
Vertebrate Carnivore	Long-Tailed Weasel, Mink, Red Fox, Racer, Milk Snake, Common Garter Snake, Water Snake, Red-Tailed Hawk, Broad-Winged Hawk, Great Horned Owl, Green Heron, Belted Kingfisher
Invertebrate Carnivore	Masked Shrew, Short-Tailed Shrew, Spotted Salamander, Dusky Salamander, Eastern Newt, Red-Backed Salamander, American Toad, Spring Peeper, Green Frog, Pickerel Frog, Northern Leopard frog, Wood Frog, Bullfrog, Spotted Turtle, Eastern Box Turtle, Common Garter Snake, Common Flicker, Blue-Winged Warbler, Ovenbird, Common Yellowthroat, American Woodcock, Black Duck
Omnivore	Deer Mouse, White-Footed Mouse, Raccoon, Snapping Turtle, Song Sparrow, Wood Duck Gray Catbird, American Robin, Wood Thrush, Veery, Rufous-Sided Towhee, Red-Winged Blackbird, Common Grackle, Swamp Sparrow
Herbivore	Red-Backed Vole, Eastern Cottontail, White-Tailed Deer, Beaver, Mallard

TABLE A-11: FEEDING GUILDS FOR PALUSTRINE NEEDLE-LEAVED EVERGREEN FORESTED WETLAND.

DESCRIPTOR	FEEDING GUILD
Vegetated Layers	
Vertebrate Carnivore	None
Invertebrate Carnivore	Gray Treefrog, Tree Swallow, Barn Swallow, Downy Woodpecker, Eastern Wood Pewee
Omnivore	Black-Capped Chickadee, Blue Jay, American Robin, Song Sparrow, Swamp Sparrow
Herbivore	None
Surface and/or Water	
Vertebrate Carnivore	Long-Tailed Weasel, Mink, Red Fox, Racer, Milk Snake, Common Garter Snake, Water Snake, Broad-Winged Hawk, Belted Kingfisher
Invertebrate Carnivore	Masked Shrew, Short-Tailed Shrew, Dusky Salamander, Eastern Newt, Red-Backed Salamander, American Toad, Spring Peeper, Green Frog, Pickerel Frog, Northern Leopard Frog, Spotted Turtle, Eastern Box Turtle, Common Garter Snake, Common Flicker, Ovenbird
Omnivore	Deer Mouse, White-Footed Mouse, Raccoon, Gray Catbird, American Robin, Veery, Red-Winged Blackbird, Common Grackle, Song Sparrow, Swamp Sparrow
Herbivore	Eastern Cottontail, White-Tailed Deer

TABLE A-12: FEEDING GUILDS FOR PALUSTRINE SCRUB-SHRUB WETLAND.

DESCRIPTOR	FEEDING GUILD
Vegetated Layers	
Vertebrate Carnivore	None
Invertebrate Carnivore	Gray Treefrog, Tree Swallow, Barn Swallow, Eastern Kingbird, Least Flycatcher, Yellow Warbler
Omnivore	Black-Capped Chickadee, American Robin, Song Sparrow, Swamp Sparrow
Herbivore	None
Surface and/or Water	
Vertebrate Carnivore	Long-Tailed Weasel, Mink, Red Fox, Racer, Milk Snake, Water Snake, Common Garter Snake, Broad-Winged Hawk, Green Heron, Belted Kingfisher
Invertebrate Carnivore	Masked Shrew, Short-Tailed Shrew, Spotted Salamander, Dusky Salamander, Eastern Newt, American Toad, Spring Peeper, Green Frog, Pickerel Frog, Northern Leopard Frog, Bullfrog, Spotted Turtle, Eastern Box Turtle, Common Garter Snake, Blue-Winged Warbler, Common Yellowthroat, American Woodcock, Black Duck
Omnivore	Deer Mouse, White-Footed Mouse, Raccoon, Snapping Turtle, Wood Duck, Gray Catbird, American Robin, Veery, Red-Winged Blackbird, Common Grackle, Song Sparrow, Swamp Sparrow
Herbivore	Red-Backed Vole, Eastern Cottontail, White-Tailed Deer, Beaver, Mallard

TABLE A-13: FEEDING GUILDS FOR PALUSTRINE EMERGENT WETLAND.

DESCRIPTOR	FEEDING GUILD
Vegetated Layers	
Vertebrate Carnivore	None
Invertebrate Carnivore	Tree Swallow, Barn Swallow, Eastern Kingbird, Least Flycatcher
Omnivore	Song Sparrow, Swamp Sparrow
Herbivore	None
Surface and/or Water	
Vertebrate Carnivore	Mink, Red Fox, Common Garter Snake, Water Snake, Spotted Sandpiper, Green Heron, Belted Kingfisher
Invertebrate Carnivore	Masked Shrew, Short-Tailed Shrew, Eastern Newt, American Toad, Green Frog, Pickerel Frog, Bullfrog, Northern Leopard Frog, Spotted Turtle, Eastern Box Turtle, Common Garter Snake, Common Yellowthroat, American Woodcock, Spotted Sandpiper, Black Duck
Omnivore	Raccoon, Snapping Turtle, Wood Duck, Gray Catbird, Red-Winged Blackbird, Common Grackle, Song Sparrow, Swamp Sparrow
Herbivore	Eastern Cottontail, White-Tailed Deer, Muskrat, Beaver, Mallard

TABLE A-14: FEEDING GUILDS FOR UPLAND DECIDUOUS FOREST.

DESCRIPTOR	FEEDING GUILD
Vegetated Layers	
Vertebrate Carnivore	None
Invertebrate Carnivore	Downy Woodpecker, Least Flycatcher, Eastern Wood Pewee, Red-Eyed Vireo, Black-and-White Warbler, Yellow Warbler
Omnivore	Blue Jay, Black-Capped Chickadee, American Robin, Northern Oriole, Song Sparrow
Herbivore	Gray Squirrel
Surface	
Vertebrate Carnivore	Long-Tailed Weasel, Mink, Red Fox, Racer, Milk Snake, Red-Tailed Hawk, Broad-Winged Hawk, Great Horned Owl
Invertebrate Carnivore	Short-Tailed Shrew, Dusky Salamander, American Toad, Wood Frog, Eastern Box Turtle, Blue-Winged Warbler, Common Flicker, Ovenbird, Common Yellowthroat, American Woodcock
Omnivore	Deer Mouse, White-Footed Mouse, Eastern Chipmunk, Raccoon, American Robin, Wood Thrush, Wood Duck, Veery, Rufous-Sided Towhee, Song Sparrow
Herbivore	Red-Backed Vole, Eastern Cottontail, White-Tailed Deer. Beaver

TABLE A-15: FEEDING GUILDS FOR UPLAND NEEDLE-LEAVED EVERGREEN FOREST.

DESCRIPTOR	FEEDING GUILD
Vegetated Layers	
Vertebrate Carnivore	None
Invertebrate Carnivore	Downy Woodpecker, Black-and-White Warbler
Omnivore	Blue Jay, Black-Capped Chickadee, American Robin
Herbivore	Red Squirrel
Surface	
Vertebrate Carnivore	Long-Tailed Weasel, Mink, Red Fox, Racer, Milk Snake, Broad-Winged Hawk, Great Horned Owl
Invertebrate Carnivore	Short-Tailed Shrew, Dusky Salamander, American Toad, Eastern Box Turtle, Common Flicker, Eastern Wood Pewee, Ovenbird
Omnivore	Deer Mouse, White-Footed Mouse, Raccoon, American Robin, Rufous-Sided Towhee, Chipping Sparrow
Herbivore	Eastern Cottontail, White-Tailed Deer

TABLE A-16: FEEDING GUILDS FOR UPLAND SCRUB-SHRUB.

DESCRIPTOR	FEEDING GUILD
Vegetated Layers	
Vertebrate Carnivore	None
Invertebrate Carnivore	Yellow Warbler
Omnivore	American Robin, Song Sparrow
Herbivore	None
Surface	
Vertebrate Carnivore	Long-Tailed Weasel, Mink, Red Fox, Racer, Milk Snake, Broad-Winged Hawk
Invertebrate Carnivore	Short-Tailed Shrew, American Toad, Blue-Winged Warbler, Common Yellowthroat, American Woodcock, Black Duck
Omnivore	Deer Mouse, White-Footed Mouse, Eastern Chipmunk, Raccoon, Gray Catbird, American Robin, Rufous-Sided Towhee, Song Sparrow, Red-Winged Blackbird
Herbivore	Red-Backed Vole, Eastern Cottontail, White-Tailed Deer, Mallard

TABLE A-17: FEEDING GUILDS FOR UPLAND FORB/GRASSLAND.

DESCRIPTOR	FEEDING GUILD
Vegetated Layers	
Vertebrate Carnivore	None
Invertebrate Carnivore	Tree Swallow, Barn Swallow, Eastern Kingbird
Omnivore	None
Herbivore	None
Surface	
Vertebrate Carnivore	Long-Tailed Weasel, Red Fox, Racer, Milk Snake, Red-Tailed Hawk, Broad-Winged Hawk, Great Horned Owl
Invertebrate Carnivore	Short-Tailed Shrew, American Toad, Common Flicker, Killdeer, American Woodcock, Black Duck
Omnivore	Deer Mouse, White-Footed Mouse, Raccoon, Gray Catbird, American Robin, Chipping Sparrow, Song Sparrow, Red-Winged Blackbird, Common Grackle
Herbivore	Eastern Cottontail, White-Tailed Deer, Mallard

TABLE A-18: FEEDING GUILDS FOR RIVERINE SYSTEM.

DESCRIPTOR	FEEDGIN GUILD
Food In and Above Water	
Vertebrate Carnivore	Mink, Water Snake, Great Blue Heron, Green Heron, Spotted Sandpiper, Belted Kingfisher
Invertebrate Carnivore	Eastern Newt, Dusky Salamander, Spotted Turtle, Bullfrog, Tree Swallow, Barn Swallow, Eastern Kingbird, Spotted Sandpiper, Black Duck
Omnivore	Snapping Turtle, Wood Duck, Common Grackle
Herbivore	Muskrat, Mallard

APPENDIX B
SUMMARY DATA TABLES

TABLE B-1: SUMMARY DATA FOR PALUSTRINE DECIDUOUS FORESTED WETLAND.

Parameter	Station Number 1	2	3	4	5	6	7
% Herb cover	58.4	4.9	18.2	27.0	52.2	53.8	61.5
% Shrub cover	8.5	36.8	16.7	4.7	29.3	38.4	67.0
% Tree cover	62.8	92.7	90.3	74.8	77.0	68.1	80.0
% Dec. trees	86.0	100.0	77.5	83.0	59.5	100.0	94.0
% Tree/shrub	66.0	93.0	93.1	76.0	89.6	79.5	94.9
% Litter	92.8	93.1	93.5	82.1	100.0	71.5	39.8
% Vole cover	10.1	3.7	1.6	9.6	6.6	23.0	12.2
Herb ht.(")	21.8	7.6	13.7	10.9	24.7	22.7	28.7
Shrub ht.(")	34.8	11.4	25.8	17.0	20.8	50.9	44.4
Tree ht.(')	59.3	53.1	45.7	53.2	39.0	44.8	55.7
dbh (")	9.6	10.6	9.6	10.5	6.7	6.2	10.7
Basal area (sq. ft./ac.)	65.6	87.8	86.7	72.2	87.8	72.2	111.1
Wood Duck cavities/ac.	4.8	19.4	12.1	7.3	0.0	0.0	0.0
Snags/ac.	16.1	55.7	16.1	19.3	33.9	12.1	70.2
Wood Frog sites/ac.	338.8	403.3	500.1	1339.0	4066.0	6001.0	8131.0
Aq. substrate	organic muck	muddy	muddy	muddy	muddy	muddy	muddy
Dusky Sal. Cov. water	readily visible	readily visible	readily visible	readily visible	readily visible	readily visible	readily visible
Dusky Sal. Cov. land (%)	26-50	26-50	0-25	0-25	26-50	26-50	26-50
% Brood cover	no water	0	60	50-60	0	90	75
% Emerg. herb littoral	no water	<1	30	5-10	0	80-100	80-100
% Aquatic Veg. littoral	no water	1	60	5-10	0	0	0
% Water cover woody veg - 1m	0	10	40	50	25	50-75	95
Soil moisture regime	sat.	sat.	sat.	sat.	sat.	sat.	sat.
Soil moisture (present)	wet	wet	wet	wet	wet	wet	wet
Soil Text.	medium	medium	medium	medium	medium	medium	medium
Soil compaction	easy	easy	easy	easy	easy	easy	easy
Water current ("/sec)	0	0	0	0	0	0.1	0.3
Dist. to Dusky water (')	0-30	0-30	0-30	0-50	0-5	0-10	0-10
Dist. to water/ wetland (')	0	0	0	0	0	0	0
Dist. to Forest opening (')	0-50	150	80	100	200	100	100

TABLE B-1: SUMMARY DATA FOR PFO1 (CONTINUED).

Parameter	Station Number 1	2	3	4	5	6	7
Dist. to perm. water (')	200	150	0-30	30	850	60	0
Dist. to clumps dec. trees or shrubs	0	0	0	0	0	0	0
% water <18"	100	100	100	100	100	50	100
% water open	0	90	30	40-50	5	5-10	60-70
Dist. to PEM	1100	500	0-30	500	800	300	400
Water regime	semi-perm.	semi-perm.	perm.	semi-perm.	semi-perm.	perm.	perm.
Water turbidity	NA	clear	clear	clear	clear	clear	clear
% yr. w/ water	50-75	50-75	100	50-75	90	100	100
Dist. to nest (Kingfisher)	200	600	1200	1000	900	500	300

TABLE B-2: SUMMARY DATA FOR PALUSTRINE NEEDLE-LEAVED EVERGREEN FORESTED WETLAND.

Parameter	Station Number 1	2	3
% Herb cover	83.8	76.2	71.4
% Shrub cover	13.4	35.2	14.5
% Tree cover	97.3	98.7	93.0
% Dec. trees	37.3	4.0	49.4
% Tree/shrub	98.6	99.6	93.7
% Woody/perst.	98.6	99.6	93.7
Herb ht.(")	11.4	23.4	13.7
Shrub ht.(")	20.0	38.3	33.6
Tree ht.(')	40.0	39.7	33.3
Basal area (sq. ft./ac.)	168.9	141.1	160.0
Snags/ac.	2.4	0.0	17.0
Dusky Sal. cov. water	readily visible	na	readily visible
Dusky Sal. Cov. land (%)	51-75	76-100	26-50
Dist. to Dusky water (')	0	400	0-10
Dist. to Forest opening (')	200	200	200
Dist. to water/ wetland (')	0	0	0
Dist. to nest Kingfisher(')	1200	400	1400
Dist. to PEM(')	1500	1200	2000
% water <18"	100	na	100
% water open	10-15	na	25
Water turbidity	clear	na	clear
Water depth(")	3	na	1
Veg. over water	75	na	75
% yr. w/ water	50	15-20	70-80

TABLE B-3: SUMMARY DATA FOR PALUSTRINE SCRUB-SHRUB WETLAND.

Parameter	Station Number 1	2	3	4	5	6	7	8
% Herb cover	100.0	100.0	40.0	79.8	67.7	69.0	92.0	41.6
% Shrub cover	88.4	93.8	35.8	51.0	79.8	17.0	43.9	48.6
% Dec. shrub cover	16.0	3.9	35.3	51.0	79.8	17.1	43.9	48.6
% of dec. shrub cover = hydro.	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
% Tree/shrub	95.5	94.1	56.7	51.0	79.8	44.9	48.5	52.9
% Litter	na	na	na	84.3	87.0	56.6	100.0	96.6
% Vole cover	0.0	0.0	0.0	53.2	31.6	24.3	11.5	9.4
Herb ht.(")	7.1	0.0	8.7	30.2	34.7	8.8	28.8	22.6
Shrub ht.(")	22.8	10.1	29.7	42.2	40.0	17.7	51.1	35.3
Aq. substrate	Sphag.	Sphag.	muddy	muddy	muddy	muddy	muddy	muddy
Dusky Sal. cov. water	readily visible	visible/ few	readily visible	readily visible	visible/ few	readily visible	none visible	none visible
Dusky Sal. cov. land (%)	26-50	76-100	0-25	26-50	51-75	51-75	0-25	26-50
% Brood cover	80-100	5	60	90	60-80	10	1	0
Dist. to water/ wetland (')	0	0	0	0	0	0	0	0
% Emerg. herb littoral	1	10	40	80-100	45	0	100	0
% Aquatic Veg.	80-100	100	60	70	0	10	0	0
% Water cover woody veg - 1m	80-100	5-10	30-40	51	60-80	20	0	0
Soil moisture regime	sat.	sat.	flood	flood	sat.	sat.	sat.	sat.
Soil moisture (present)	wet	wet	wet	wet	wet	wet	wet	wet
Soil Text.	Sphag.	Sphag.	medium	medium	medium	medium	medium	medium
Soil compaction	easy	easy	easy	easy	easy	easy	easy	easy
Dist. to Dusky water (')	0	0	0	0	0-15	0-5	150	40-50
Dist. to perm. water (')	0	0	0	0-50	100	80	150	40-50
% water <18"	100	100	80	90	100	100	100	na
% water open	0-20	0	40	5	20-40	90	0	na
Dist. to PEM(')	700	150	50	50-100	100	1000	150	50-100
Water regime	perm.	perm.	perm.	perm.	semi-perm.	semi-perm.	semi-perm.	semi-perm.
% yr. w/ water	100	100	100	95-100	50-75	80-90	80-90	15-25

TABLE B-4: SUMMARY DATA FOR PALUSTRINE EMERGENT MARSH WETLAND.

Parameter	Station Number 1	2	3	4
% Herb cover	55.6	77.2	79.4	80-90
% Woody cov.	0.0	0.0	5.0	0.0
Herb ht.(")	13.7	7.9	13.7	17.0
Aq. substrate	muddy	muddy	muddy	muddy
% Brood cover	40	50-60	70	10-15
% Emerg. herb	40-50	50-60	70	10-15
% Aquatic Veg.	75-95	95-100	90-100	80-90
% Water cover woody veg - 1m	1-5	1-5	5-10	10-20
% Veg. cover of water	40-50	80	70-90	80-90
Dist. to clumps of dec. trees/ shrubs (')	75-100	125	80-100	100-150
Dist. to nest Kingfisher(')	1000	200	800	1000
Dist. to SS/FO (')	75-100	0-100	80-100	100-150
% water <18"	100	90-95	90-100	80-90
% water open	50-60	20	30	10-20
Water regime	perm.	perm.	perm.	perm.
% yr. w/ water	100	100	100	100
% water <10"	40-45	55-60	70-90	50

TABLE B-5: SUMMARY DATA FOR PALUSTRINE EMERGENT SEDGE WETLAND.

Parameter	Station Number 1	2	3	4	5
% Herb cover	98.7	61.7	46.0	52.2	83.6
% Woody cov.	6.9	3.7	0.4	23.2	12.3
Herb ht.(")	30.8	16.1	12.3	18.8	21.8
Aq. substrate	muddy	muddy	muddy	muddy	muddy
% Brood cover	100	50	50	20	80-90
% Emerg. herb	100	0	0	15-20	100
% Aquatic Veg.	0	0	0	75	100
% Water cover woody veg - 1m	5-10	5	<5	10	30-40
% Veg. cover of water	100	50	50	75	90
Dist. to clumps of dec. trees/ shrubs (')	50	50-100	50	0-20	0-20
Dist. to nest Kingfisher(')	300	750	1250	600	500
Dist. to SS/FO (')	50	50-100	50	0-20	0-20
% water <18"	100	100	100	100	100
% water open	5	50	50	25	10-20
Water regime	semi-perm.	semi-perm.	semi-perm.	semi-perm.	semi-perm.
% yr. w/ water	50-75	80	90	90-100	75-85
% water <10"	100	100	100	100	100

TABLE B-6: SUMMARY DATA FOR UPLAND DECIDUOUS FOREST.

Parameter	Station Number 1	2	3	4	5	6	7
% Herb cover	35.6	90.7	21.9	25.0	41.5	77.4	37.7
% Shrub cover	65.0	81.2	23.0	70.7	68.5	57.6	44.7
% Tree cover	99.4	93.9	95.0	91.0	90.0	90.5	75.3
% Tree/shrub	99.6	99.8	96.7	96.5	94.7	93.8	84.4
% Litter	100.0	100.0	98.6	98.5	96.2	100.0	99.6
% Vole cover	3.0	0.3	2.7	1.8	42.8	0.7	1.2
Herb ht.(")	3.0	6.0	5.2	8.9	7.0	9.3	6.4
Shrub ht.(")	23.2	30.4	12.8	19.7	11.6	17.6	26.9
Tree ht.(')	49.7	35.1	46.7	46.0	63.3	43.8	51.7
dbh (")	7.7	4.0	6.8	7.1	14.0	7.8	9.1
Basal area (sq. ft./ac.)	134.4	57.8	137.8	85.6	96.7	68.9	107.8
Wood Duck cavities/ac.	2.4	0.0	4.8	0.0	4.9	0.0	4.8
Snags/ac.	43.6	16.9	29.0	31.5	41.1	15.5	58.1
Wood Frog sites/ac.	161.3	322.6	1258.0	145.2	7308.0	274.3	6421.0
Dusky Sal. Cov. land (%)	0-25	0-25	0-25	0-25	0-25	0-25	0-25
Soil moisture regime	moist	dry	moist	moist	dry	moist	moist
Soil moisture (present)	moist	moist	dry	moist	moist	moist	moist
Soil Text.	medium	coarse	medium	medium	medium	medium	medium
Soil compaction	easy	easy	easy	diffi-cult	easy	easy	easy
Dist. to Dusky water (')	100	100	35-40	120	200	100	45
Dist. to Vole water (')	75-100	100	35-40	120	200	100	45
Dist. to Forest opening (')	100	100-150	35-40	200	70-100	250	100
Dist. to perm. water (')	100	600	200	1100	75	150	1300

TABLE B-7: SUMMARY DATA FOR UPLAND NEEDLE-LEAVED EVERGREEN FOREST.

Parameter	Station Number 1	2	3	4	5	6	7
% Herb cover	69.9	64.0	32.1	29.5	25.4	28.2	73.0
% Shrub cover	51.1	50.2	36.6	46.7	50.1	27.4	21.6
Herb ht.(")	4.7	6.1	6.6	6.1	3.0	4.4	4.8
Tree ht.(')	89.6	80.1	45.4	51.2	39.9	62.0	59.4
Basal area (sq. ft./ac.)	170.0	175.6	118.9	110.0	115.6	110.0	127.8
Snags/ac.	4.8	7.3	4.9	14.5	0.0	2.4	7.3
Dusky Sal. Cov. land (%)	0-25	0-25	0-25	0-25	0-25	0-25	0-25
Dist. to Dusky water (')	100	100-150	0-50	30-60	50	150	50-100
Dist. to Forest opening (')	200	50-100	100-125	50-100	50	100	50-100
Dist. to water/ wetland (')	100	100-150	0-50	30-60	50	150	50

TABLE B-8: SUMMARY DATA FOR UPLAND SCRUB-SHRUB.

Parameter	Station Number 1	2	3	4	5
% Herb cover	90.5	98.1	73.0	49.8	85.2
% Shrub cover	66.5	64.4	91.3	82.4	67.4
% Dec. shrub cover	66.5	64.4	77.2	82.4	67.4
% of dec. shrub cover = hydro.	100.0	100.0	7.8	0.0	0.0
% Vole cover	13.9	1.1	12.9	5.4	0.0
Herb ht.(")	18.6	28.6	20.0	14.1	16.9
Shrub ht.(")	58.1	93.9	24.2	35.2	16.6
Dist. to water/ wetland (')	50	25-50	100	750	300

TABLE B-9: SUMMARY DATA FOR UPLAND FORB/GRASSLAND.

Parameter	Station Number 1	2	3	4	5	6
% Herb cover	98.9	94.4	81.4	97.3	100.0	42.3
% Litter	100.0	50.4	46.5	100.0	100.0	27.5
% Trees/shrubs	4.7	0.0	0.3	3.9	1.8	11.6
Herb ht.(")	25.6	6.9	5.0	15.1	17.0	6.1
Dist. to water/ wetland (')	50	150	100-125	50-100	50-75	125
Soil moisture	moist	moist	moist	moist	moist	moist
Soil text.	medium	coarse	coarse	medium	coarse	coarse
Soil compaction	easy	diffi-cult	diffi-cult	diffi-cult	easy	easy

TABLE B-10: SUMMARY DATA FOR RIVERINE SYSTEM.

Parameter	Station Number 1	2	3	4	5	6	7
% Herb cover within 10m	64.7	43.0	22.2	33.0	34.3	93.3	75.7
% Woody cov. within 100m	0.0	3.6	59.0	100.0	100.0	62.3	94.6
% Woody cov. within 100m of wetland	95.3	98.7	94.3	100.0	100.0	93.0	94.6
Water current "/sec	0.0	0.1	0.2	0.0	0.0	1.8	2.1
% Brood cover	5-10	15-20	15	5	35	35	15
Aq. substrate	muddy	muddy	muddy	muddy	rocky	muddy	muddy
% water <10"	30	10-15	15	20	50	40	10
% Emerg. herb	5	0	35	0	0	0	0
% Water cover woody veg - 1m	5	15-20	10-15	5	10	35	15
Dist. to clumps of dec. trees/ shrubs (')	10	3-15	0-10	15	5-10	0-5	0-15
Water turbidity	clear	clear	clear	clear	clear	clear	clear
Av. water depth	3	4-5	2-3	3	2.5	1.7	2
% Veg. cover of water	10	15-20	25-30	5	35	35	15
Dist. to nest Kingfisher(')	600	600	800	1000	900	900	400
% Aquatic Veg.	20-25	1	30-35	1	0	15	0
Dusky Sal. Cov. water	visible/ few	visible/ few	visible/ few	visible/ few	readily visible	readily visible	readily visible

TABLE B-10: SUMMARY DATA FOR RIVERINE SYSTEM (CONTINUED).

Parameter	Station Number 1	2	3	4	5	6	7
Dusky Sal. Cov. within 50'	50-75	25-50	26-50	0-25	0-25	25-50	0-25
Dusky Sal. Cov. within 50' of wetland	30-35	0-25	26-50	0-25	0-25	0-25	0-25
Bank soil text.	medium	medium	medium	fine	medium	medium	medium

APPENDIX C
BASELINE AND PROJECTED HABITAT UNITS
WITHOUT PROJECT IMPLEMENTATION

TABLE C-1: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR RED-BACKED VOLE WITHOUT PROJECT IMPLEMENTATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.57	37.05
UFO1	384	0.26	99.84
PSS	62	0.30	18.60
USS	17	0.24	4.08
TOTAL	528		159.57
MEAN WEIGHTED HSI		0.30	
		TY 1	
PFO1	65	0.57	37.05
UFO1	381	0.26	99.06
PSS	62	0.30	18.60
USS	17	0.24	4.08
TOTAL	525		158.79
MEAN WEIGHTED HSI		0.30	
		TY 50	
PFO1	65	0.57	37.05
UFO1	189	0.26	49.14
PSS	62	0.30	18.60
USS	17	0.24	4.08
TOTAL	333		108.87
MEAN WEIGHTED HSI		0.33	
		TY 100	
PFO1	65	0.57	37.05
UFO1	195	0.26	50.70
PSS	62	0.30	18.60
USS	17	0.24	4.08
TOTAL	339		110.43
MEAN WEIGHTED HSI		0.33	

TABLE C-2: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR MINK WITHOUT PROJECT IMPLEMENTATION.

Cover Type	Area + Upland Habitat	Mean HSI	Habitat Units
		TY 0	
PFO1	175	0.89	155.75
PFO4	38	0.50	19.00
PSS	165	0.77	127.05
PEMM	38	1.00	38.00
PEMS	11	0.94	10.34
RIV	39	1.00	39.00
TOTAL	466		389.14
MEAN WEIGHTED HSI		0.84	
		TY 1	
PFO1	175	0.89	155.75
PFO4	38	0.50	19.00
PSS	165	0.77	127.05
PEMM	38	1.00	38.00
PEMS	11	0.94	10.34
RIV	39	1.00	39.00
TOTAL	466		389.14
MEAN WEIGHTED HSI		0.84	
		TY 50	
PFO1	175	0.89	155.75
PFO4	38	0.50	19.00
PSS	165	0.77	127.05
PEMM	38	1.00	38.00
PEMS	11	0.94	10.34
RIV	39	1.00	39.00
TOTAL	466		389.14
MEAN WEIGHTED HSI		0.84	

TABLE C-2: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR MINK WITHOUT PROJECT IMPLEMENTATION (CONTINUED).

		TY 100	
PFO1	175	0.89	155.75
PFO4	38	0.50	19.00
PSS	165	0.77	127.05
PEMM	38	1.00	38.00
PEMS	11	0.94	10.34
RIV	39	1.00	39.00
TOTAL	466		389.14
MEAN WEIGHTED HSI		0.84	

TABLE C-3: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR MUSKRAT WITHOUT PROJECT IMPLEMENTATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
RIV	13	0.51	6.63
PEMM	18	0.63	11.34
PEMS	10	0.20	2.00
TOTAL	41		19.97
MEAN WEIGHTED HSI		0.49	
		TY 1	
RIV	13	0.51	6.63
PEMM	18	0.63	11.34
PEMS	10	0.20	2.00
TOTAL	41		19.97
MEAN WEIGHTED HSI		0.49	
		TY 50	
RIV	13	0.51	6.63
PEMM	18	0.76	13.68
PEMS	10	0.20	2.00
TOTAL	41		22.31
MEAN WEIGHTED HSI		0.54	
		TY 100	
RIV	13	0.51	6.63
PEMM	18	0.76	13.68
PEMS	10	0.20	2.00
TOTAL	41		22.31
MEAN WEIGHTED HSI		0.54	

TABLE C-4: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR DUSKY SALAMANDER WITHOUT PROJECT IMPLEMENTATION.

Cover Type	Acres	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.65	42.25
PFO4	23	0.55	12.65
PSS	62	0.53	32.86
RIV	13	0.77	10.01
UFO1	384	0.01	3.84
UFO4	77	0.06	4.62
TOTAL	624		106.23
MEAN WEIGHTED HSI		0.17	
		TY 1	
PFO1	65	0.65	42.25
PFO4	23	0.55	12.65
PSS	62	0.53	32.86
RIV	13	0.77	10.01
UFO1	381	0.01	3.81
UFO4	75	0.06	4.50
TOTAL	619		106.08
MEAN WEIGHTED HSI		0.17	
		TY 50	
PFO1	65	0.65	42.25
PFO4	23	0.55	12.65
PSS	62	0.53	32.86
RIV	13	0.77	10.01
UFO1	189	0.01	1.89
UFO4	273	0.06	16.38
TOTAL	625		116.04
MEAN WEIGHTED HSI		0.19	

TABLE C-4: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR DUSKY SALAMANDER WITHOUT PROJECT IMPLEMENTATION (CONTINUED).

		TY 100	
PFO1	65	0.65	42.25
PFO4	23	0.55	12.65
PSS	62	0.53	32.86
RIV	13	0.77	10.01
UFO1	195	0.01	1.95
UFO4	273	0.06	16.38
TOTAL	631		116.10
MEAN WEIGHTED HSI		0.18	

TABLE C-5: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR WOOD FROG WITHOUT PROJECT IMPLEMENTATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.95	61.75
UFO1	384	0.81	311.04
TOTAL	449		372.79
MEAN WEIGHTED HSI		0.83	
		TY 1	
PFO1	65	0.95	61.75
UFO1	381	0.81	308.61
TOTAL	446		370.36
MEAN WEIGHTED HSI		0.83	
		TY 50	
PFO1	65	0.95	61.75
UFO1	189	0.81	153.09
TOTAL	254		214.84
MEAN WEIGHTED HSI		0.85	
		TY 100	
PFO1	65	0.95	61.75
UFO1	195	0.81	157.95
TOTAL	260		219.70
MEAN WEIGHTED HSI		0.85	

TABLE C-6: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR SNAPPING TURTLE WITHOUT PROJECT IMPLEMENTATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.00	0.00
PSS	62	0.24	14.88
PEMM	18	0.93	16.74
PEMS	10	0.00	0.00
RIV	13	0.17	2.21
TOTAL	168		33.83
MEAN WEIGHTED HSI		0.20	
		TY 1	
PFO1	65	0.00	0.00
PSS	62	0.24	14.88
PEMM	18	0.93	16.74
PEMS	10	0.00	0.00
RIV	13	0.17	2.21
TOTAL	168		33.83
MEAN WEIGHTED HSI		0.20	
		TY 50	
PFO1	65	0.00	0.00
PSS	62	0.24	14.88
PEMM	18	0.93	16.74
PEMS	10	0.00	0.00
RIV	13	0.17	2.21
TOTAL	168		33.83
MEAN WEIGHTED HSI		0.20	

TABLE C-6: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR SNAPPING TURTLE WITHOUT PROJECT IMPLEMENTATION (CONTINUED).

		TY 100	
PFO1	65	0.00	0.00
PSS	62	0.24	14.88
PEMM	18	0.93	16.74
PEMS	10	0.00	0.00
RIV	13	0.17	2.21
TOTAL	168		33.83
MEAN WEIGHTED HSI		0.20	

TABLE C-7: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR GREEN HERON WITHOUT PROJECT IMPLEMENTATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.77	50.05
PSS	62	0.64	39.68
PEMM	18	1.00	18.00
PEMS	10	0.77	7.70
RIV	13	0.94	12.22
TOTAL	168		127.65
MEAN WEIGHTED HSI		0.76	
		TY 1	
PFO1	65	0.77	50.05
PSS	62	0.64	39.68
PEMM	18	1.00	18.00
PEMS	10	0.77	7.70
RIV	13	0.94	12.22
TOTAL	168		127.65
MEAN WEIGHTED HSI		0.76	
		TY 50	
PFO1	65	0.77	50.05
PSS	62	0.64	39.68
PEMM	18	1.00	18.00
PEMS	10	0.77	7.70
RIV	13	0.94	12.22
TOTAL	168		127.65
MEAN WEIGHTED HSI		0.76	

TABLE C-7: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR GREEN HERON WITHOUT PROJECT IMPLEMENTATION (CONTINUED).

		TY 100	
PFO1	65	0.77	50.05
PSS	62	0.64	39.68
PEMM	18	1.00	18.00
PEMS	10	0.77	7.70
RIV	13	0.94	12.22
TOTAL	168		127.65
MEAN WEIGHTED HSI		0.76	

TABLE C-8: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR BLACK DUCK WITHOUT PROJECT IMPLEMENTATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.39	25.35
PSS	62	0.31	19.22
PEMM	18	0.56	10.08
PEMS	10	0.60	6.00
TOTAL	155		60.65
MEAN WEIGHTED HSI		0.39	
		TY 1	
PFO1	65	0.39	25.35
PSS	62	0.31	19.22
PEMM	18	0.56	10.08
PEMS	10	0.60	6.00
TOTAL	155		60.65
MEAN WEIGHTED HSI		0.39	
		TY 50	
PFO1	65	0.39	25.35
PSS	62	0.31	19.22
PEMM	18	0.56	10.08
PEMS	10	0.60	6.00
TOTAL	155		60.65
MEAN WEIGHTED HSI		0.39	
		TY 100	
PFO1	65	0.39	25.35
PSS	62	0.31	19.22
PEMM	18	0.56	10.08
PEMS	10	0.60	6.00
TOTAL	155		60.65
MEAN WEIGHTED HSI		0.39	

TABLE C-9: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR WOOD DUCK WITHOUT PROJECT IMPLEMENTATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
HABITAT			
UFO1	384		
PFO1	65		
PSS	62		
PEMM	18		
PEMS	10		
RIV	13		
TOTAL	552	0.16	88.32
		TY 1	
HABITAT			
UFO1	381		
PFO1	65		
PSS	62		
PEMM	18		
PEMS	10		
RIV	13		
TOTAL	549	0.16	87.84
		TY 50	
HABITAT			
UFO1	189		
PFO1	65		
PSS	62		
PEMM	18		
PEMS	10		
RIV	13		
TOTAL	357	0.25	89.25
		TY 100	
HABITAT			
UFO1	195		
PFO1	65		
PSS	62		
PEMM	18		
PEMS	10		
RIV	13		
TOTAL	363	0.25	90.75

TABLE C-10: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR BROAD-WINGED HAWK WITHOUT PROJECT IMPLEMENTATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
HABITAT			
UF01	384		
UF04	77		
USS	17		
UF/G	25		
PF01	65		
PF04	23		
PSS	62		
TOTAL	653	1.00	653.00
		TY 1	
HABITAT			
UF01	381		
UF04	75		
USS	17		
UF/G	30		
PF01	65		
PF04	23		
PSS	62		
TOTAL	653	1.00	653.00
		TY 50	
HABITAT			
UF01	189		
UF04	273		
USS	17		
UF/G	24		
PF01	65		
PF04	23		
PSS	62		
TOTAL	653	1.00	653.00
		TY 100	
HABITAT			
UF01	195		
UF04	273		
USS	17		
UF/G	18		
PF01	65		
PF04	23		
PSS	62		
TOTAL	653	1.00	653.00

TABLE C-11: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR AMERICAN WOODCOCK WITHOUT PROJECT IMPLEMENTATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
HABITAT			
UFO1	384		
PFO1	65		
PSS	62		
UF/G	25		
TOTAL	536	0.34	182.24
		TY 1	
HABITAT			
UFO1	381		
PFO1	65		
PSS	62		
UF/G	30		
TOTAL	538	0.41	220.58
		TY 50	
HABITAT			
UFO1	189		
PFO1	65		
PSS	62		
UF/G	24		
TOTAL	340	0.52	176.80
		TY 100	
HABITAT			
UFO1	195		
PFO1	65		
PSS	62		
UF/G	18		
TOTAL	340	0.39	132.60

TABLE C-12: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR BELTED KINGFISHER WITHOUT PROJECT IMPLEMENTATION.

Cover Type	Acres	Mean HSI	Habitat Units
		TY 0	
RIV	13	0.96	12.48
PEMM	18	0.63	11.34
PEMS	10	0.38	3.80
PSS	62	0.08	4.96
PFO1	65	0.06	3.90
PFO4	23	0.00	0.00
TOTAL	191		36.48
MEAN WEIGHTED HSI		0.19	
		TY 1	
RIV	13	0.96	12.48
PEMM	18	0.63	11.34
PEMS	10	0.38	3.80
PSS	62	0.08	4.96
PFO1	65	0.06	3.90
PFO4	23	0.00	0.00
TOTAL	191		36.48
MEAN WEIGHTED HSI		0.19	
		TY 50	
RIV	13	0.96	12.48
PEMM	18	0.63	11.34
PEMS	10	0.38	3.80
PSS	62	0.08	4.96
PFO1	65	0.06	3.90
PFO4	23	0.00	0.00
TOTAL	191		36.48
MEAN WEIGHTED HSI		0.19	

TABLE C-12: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR BELTED KINGFISHER WITHOUT PROJECT IMPLEMENTATION (CONTINUTED).

		TY 100	
RIV	13	0.96	12.48
PEMM	18	0.63	11.34
PEMS	10	0.38	3.80
PSS	62	0.08	4.96
PFO1	65	0.06	3.90
PFO4	23	0.00	0.00
TOTAL	191		36.48
MEAN WEIGHTED HSI		0.19	

TABLE C-13: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR DOWNY WOODPECKER WITHOUT PROJECT IMPLEMENTATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.96	62.40
PFO4	23	0.33	7.59
UFO1	384	0.81	311.04
UFO4	77	0.48	36.96
TOTAL	549		417.99
MEAN WEIGHTED HSI		0.76	
		TY 1	
PFO1	65	0.96	62.40
PFO4	23	0.33	7.59
UFO1	381	0.81	308.61
UFO4	75	0.48	36.00
TOTAL	544		414.60
MEAN WEIGHTED HSI		0.76	
		TY 50	
PFO1	65	0.96	62.40
PFO4	23	0.33	7.59
UFO1	189	0.81	153.09
UFO4	273	0.48	131.04
TOTAL	550		354.12
MEAN WEIGHTED HSI		0.64	
		TY 100	
PFO1	65	0.96	62.40
PFO4	23	0.33	7.59
UFO1	195	0.81	157.95
UFO4	273	0.48	131.04
TOTAL	556		358.98
MEAN WEIGHTED HSI		0.64	

TABLE C-14: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR YELLOW WARBLER WITHOUT PROJECT IMPLEMENTATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PSS	62	0.50	31.00
USS	17	0.49	8.33
TOTAL	79		39.33
MEAN WEIGHTED HSI		0.50	
		TY 1	
PSS	62	0.50	31.00
USS	17	0.49	8.33
TOTAL	79		39.33
MEAN WEIGHTED HSI		0.50	
		TY 50	
PSS	62	0.50	31.00
USS	17	0.49	8.33
TOTAL	79		39.33
MEAN WEIGHTED HSI		0.50	
		TY 100	
PSS	62	0.50	31.00
USS	17	0.49	8.33
TOTAL	79		39.33
MEAN WEIGHTED HSI		0.50	

TABLE C-15: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR SWAMP SPARROW WITHOUT PROJECT IMPLEMENTATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.54	35.10
PSS	62	0.80	49.60
PEMM	18	0.80	14.40
PEMS	10	0.90	9.00
PFO4	23	0.48	11.04
TOTAL	178		119.14
MEAN WEIGHTED HSI		0.67	
		TY 1	
PFO1	65	0.54	35.10
PSS	62	0.80	49.60
PEMM	18	0.80	14.40
PEMS	10	0.90	9.00
PFO4	23	0.48	11.04
TOTAL	178		119.14
MEAN WEIGHTED HSI		0.67	
		TY 50	
PFO1	65	0.54	35.10
PSS	62	0.80	49.60
PEMM	18	0.80	14.40
PEMS	10	0.90	9.00
PFO4	23	0.48	11.04
TOTAL	178		119.14
MEAN WEIGHTED HSI		0.67	

TABLE C-15: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR SWAMP SPARROW WITHOUT PROJECT IMPLEMENTATION (CONTINUED).

		TY 100	
PFO1	65	0.54	35.10
PSS	62	0.80	49.60
PEMM	18	0.80	14.40
PEMS	10	0.90	9.00
PFO4	23	0.48	11.04
TOTAL	178		119.14
MEAN WEIGHTED HSI		0.67	

APPENDIX D
BASELINE AND PROJECTED HABITAT UNITS
WITH PROJECT IMPLEMENTATION
WITHOUT MITIGATION

TABLE D-1: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR RED-BACKED VOLE WITH PROJECT WITHOUT MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.57	37.05
UFO1	384	0.26	99.84
PSS	62	0.30	18.60
USS	17	0.24	4.08
TOTAL	528		159.57
MEAN WEIGHTED HSI		0.30	
		TY 1	
PFO1	7	0.57	3.99
UFO1	361	0.26	93.86
PSS	11	0.11	1.21
USS	14	0.24	3.36
TOTAL	393		102.42
MEAN WEIGHTED HSI		0.26	
		TY 10	
PFO1	7	0.57	3.99
UFO1	325	0.26	84.50
PSS	14	0.18	2.52
USS	36	0.24	8.64
TOTAL	382		99.65
MEAN WEIGHTED HSI		0.26	
		TY 35	
PFO1	7	0.57	3.99
UFO1	235	0.26	61.10
PSS	14	0.18	2.52
USS	36	0.24	8.64
TOTAL	292		76.25
MEAN WEIGHTED HSI		0.26	

TABLE D-1: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR RED-BACKED VOLE WITH PROJECT WITHOUT MITIGATION (CONTINUED).

		TY 50	
PFO1	7	0.57	3.99
UFO1	181	0.26	47.06
PSS	14	0.18	2.52
USS	36	0.24	8.64
TOTAL	238		62.21
MEAN WEIGHTED HSI		0.26	
		TY 100	
PFO1	7	0.57	3.99
UFO1	186	0.26	48.36
PSS	14	0.18	2.52
USS	36	0.24	8.64
TOTAL	243		63.51
MEAN WEIGHTED HSI		0.26	

TABLE D-2: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR MINK WITH PROJECT WITHOUT MITIGATION.

Cover Type	Area + Upland Habitat	Mean HSI	Habitat Units
		TY 0	
PFO1	175	0.89	155.75
PFO4	38	0.50	19.00
PSS	165	0.77	127.05
PEMM	38	1.00	38.00
PEMS	11	0.94	10.34
RIV	39	1.00	39.00
TOTAL	466		389.14
MEAN WEIGHTED HSI		0.84	
		TY 1	
PFO1	36	0.89	32.04
PFO4	38	0.50	19.00
PSS	28	0.91	25.48
PEMM	24	1.00	24.00
PEMS	0	0.00	0.00
RIV	6	1.00	6.00
UPLAND AROUND PERM POOL	111	0.00	0.00
TOTAL	243		106.52
MEAN WEIGHTED HSI		0.44	
		TY 10	
PFO1	36	0.89	32.04
PFO4	38	0.50	19.00
PSS	31	0.86	26.66
PEMM	89	0.90	80.10
PEMS	0	0.00	0.00
RIV	6	1.00	6.00
UPLAND AROUND PERM POOL	111	0.99	109.89
TOTAL	311		273.69
MEAN WEIGHTED HSI		0.88	

TABLE D-2: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR MINK WITH PROJECT WITHOUT MITIGATION (CONINTUED).

		TY 35	
PFO1	36	0.89	32.04
PFO4	38	0.50	19.00
PSS	31	0.86	26.66
PEMM	113	1.00	113.00
PEMS	0	0.00	0.00
RIV	6	1.00	6.00
UPLAND AROUND PERM POOL	111	0.99	109.89
TOTAL	335		306.59
MEAN WEIGHTED HSI		0.92	
		TY 50	
PFO1	36	0.89	32.04
PFO4	38	0.50	19.00
PSS	31	0.86	26.66
PEMM	113	1.00	113.00
PEMS	0	0.00	0.00
RIV	6	1.00	6.00
UPLAND AROUND PERM POOL	111	0.99	109.89
TOTAL	335		306.59
MEAN WEIGHTED HSI		0.92	
		TY 100	
PFO1	36	0.89	32.04
PFO4	38	0.50	19.00
PSS	31	0.86	26.66
PEMM	113	1.00	113.00
PEMS	0	0.00	0.00
RIV	6	1.00	6.00
UPLAND AROUND PERM POOL	111	0.99	109.89
TOTAL	335		306.59
MEAN WEIGHTED HSI		0.92	

TABLE D-3: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR MUSKRAT WITH PROJECT WITHOUT MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
RIV	13	0.51	6.63
PEMM	18	0.63	11.34
PEMS	10	0.20	2.00
TOTAL	41		19.97
MEAN WEIGHTED HSI		0.49	
		TY 1	
RIV	2	0.51	1.02
PEMM	7	0.63	4.41
PEMS	0	0.00	0.00
TOTAL	9		5.43
MEAN WEIGHTED HSI		0.60	
		TY 10	
RIV	2	0.51	1.02
PEMM	18	0.44	7.92
PEMS	0	0.00	0.00
TOTAL	20		8.94
MEAN WEIGHTED HSI		0.45	
		TY35	
RIV	2	0.51	1.02
PEMM	42	0.42	17.64
PEMS	0	0.00	0.00
TOTAL	44		18.66
MEAN WEIGHTED HSI		0.42	

TABLE D-3: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR MUSKRAT WITH PROJECT WITHOUT MITIGATION (CONTINUED).

		TY 50	
RIV	2	0.51	1.02
PEMM	42	0.43	18.06
PEMS	0	0.00	0.00
TOTAL	44		19.08
MEAN WEIGHTED HSI		0.43	
		TY 100	
RIV	2	0.51	1.02
PEMM	42	0.43	18.06
PEMS	0	0.00	0.00
TOTAL	44		19.08
MEAN WEIGHTED HSI		0.43	

TABLE D-4: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR DUSKY SALAMANDER WITH PROJECT WITHOUT MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.65	42.25
PFO4	23	0.55	12.65
PSS	62	0.53	32.86
RIV	13	0.77	10.01
UFO1	384	0.01	3.84
UFO4	77	0.06	4.62
TOTAL	624		106.23
MEAN WEIGHTED HSI		0.17	
		TY 1	
PFO1	7	0.65	4.55
PFO4	23	0.55	12.65
PSS	11	0.67	7.37
RIV	2	0.77	1.54
UFO1	361	0.01	3.61
UFO4	67	0.06	4.02
TOTAL	471		33.74
MEAN WEIGHTED HSI		0.07	
		TY 10	
PFO1	7	0.65	4.55
PFO4	23	0.55	12.65
PSS	14	0.62	8.68
RIV	2	0.77	1.54
UFO1	325	0.01	3.25
UFO4	104	0.06	6.24
TOTAL	475		36.91
MEAN WEIGHTED HSI		0.08	

TABLE D-4: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR DUSKY SALAMANDER WITH PROJECT WITHOUT MITIGATION (CONTINUED).

		TY 35	
PFO1	7	0.65	4.55
PFO4	23	0.55	12.65
PSS	14	0.62	8.68
RIV	2	0.77	1.54
UFO1	235	0.01	2.35
UFO4	197	0.06	11.82
TOTAL	478		41.59
MEAN WEIGHTED HSI		0.09	
		TY 50	
PFO1	7	0.65	4.55
PFO4	23	0.55	12.65
PSS	14	0.62	8.68
RIV	2	0.77	1.54
UFO1	181	0.01	1.81
UFO4	252	0.06	15.12
TOTAL	479		44.35
MEAN WEIGHTED HSI		0.09	
		TY 100	
PFO1	7	0.65	4.55
PFO4	23	0.55	12.65
PSS	14	0.62	8.68
RIV	2	0.77	1.54
UFO1	186	0.01	1.86
UFO4	252	0.06	15.12
TOTAL	484		44.40
MEAN WEIGHTED HSI		0.09	

TABLE D-5: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR WOOD FROG WITH PROJECT WITHOUT MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.95	61.75
UFO1	384	0.81	311.04
TOTAL	449		372.79
MEAN WEIGHTED HSI		0.83	
		TY 1	
PFO1	7	0.95	6.65
UFO1	361	0.81	292.41
TOTAL	368		299.06
MEAN WEIGHTED HSI		0.81	
		TY 10	
PFO1	7	0.95	6.65
UFO1	325	0.81	263.25
TOTAL	332		269.90
MEAN WEIGHTED HSI		0.81	
		TY 35	
PFO1	7	0.95	6.65
UFO1	235	0.81	190.35
TOTAL	242		197.00
MEAN WEIGHTED HSI		0.81	

TABLE D-5: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR WOOD FROG WITH PROJECT WITHOUT MITIGATION (CONTINUED).

		TY 50	
PFO1	7	0.95	6.65
UFO1	181	0.81	146.61
TOTAL	188		153.26
MEAN WEIGHTED HSI		0.82	
		TY 100	
PFO1	7	0.95	6.65
UFO1	186	0.81	150.66
TOTAL	193		157.31
MEAN WEIGHTED HSI		0.82	

TABLE D-6: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR SNAPPING TURTLE WITH PROJECT WITHOUT MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.00	0.00
PSS	62	0.24	14.88
PEMM	18	0.93	16.74
PEMS	10	0.00	0.00
RIV	13	0.17	2.21
TOTAL	168		33.83
MEAN WEIGHTED HSI		0.20	
		TY 1	
PFO1	7	0.00	0.00
PSS	11	0.09	0.99
PEMM	7	0.93	6.51
PEMS	0	0.00	0.00
RIV	2	0.17	0.34
PERM POOL	103	0.00	0.00
TOTAL	130		7.84
MEAN WEIGHTED HSI		0.06	
		TY 10	
PFO1	7	0.00	0.00
PSS	14	0.14	1.96
PEMM	18	0.51	9.18
PEMS	0	0.00	0.00
RIV	2	0.17	0.34
PERM POOL	103	0.05	5.15
TOTAL	144		16.63
MEAN WEIGHTED HSI		0.12	

TABLE D-6: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR SNAPPING TURTLE WITH PROJECT WITHOUT MITIGATION (CONTINUED).

		TY 35	
PFO1	7	0.00	0.00
PSS	14	0.14	1.96
PEMM	42	0.40	16.80
PEMS	0	0.00	0.00
RIV	2	0.17	0.34
PERM POOL	103	0.15	15.45
TOTAL	168		34.55
MEAN WEIGHTED HSI		0.21	
		TY 50	
PFO1	7	0.00	0.00
PSS	14	0.14	1.96
PEMM	42	0.40	16.80
PEMS	0	0.00	0.00
RIV	2	0.17	0.34
PERM POOL	103	0.21	21.63
TOTAL	168		40.73
MEAN WEIGHTED HSI		0.24	
		TY 100	
PFO1	7	0.00	0.00
PSS	14	0.14	1.96
PEMM	42	0.40	16.80
PEMS	0	0.00	0.00
RIV	2	0.17	0.34
PERM POOL	103	0.42	43.26
TOTAL	168		62.36
MEAN WEIGHTED HSI		0.37	

TABLE D-7: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR GREEN HERON WITH PROJECT WITHOUT MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.77	50.05
PSS	62	0.64	39.68
PEMM	18	1.00	18.00
PEMS	10	0.77	7.70
RIV	13	0.94	12.22
TOTAL	168		127.65
MEAN WEIGHTED HSI		0.76	
		TY 1	
PFO1	7	0.77	5.39
PSS	11	0.55	6.05
PEMM	7	1.00	7.00
PEMS	0	0.00	0.00
RIV	2	0.94	1.88
STRIPPED AUG POOL	17	0.00	0.00
TOTAL	44		20.32
MEAN WEIGHTED HSI		0.46	
		TY 10	
PFO1	7	0.77	5.39
PSS	14	0.58	8.12
PEMM	18	0.87	15.66
PEMS	0	0.00	0.00
RIV	2	0.94	1.88
STRIPPED AUG POOL	17	0.48	8.16
TOTAL	58		39.21
MEAN WEIGHTED HSI		0.68	

TABLE D-7: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR GREEN HERON WITH PROJECT WITHOUT MITIGATION (CONTINUED).

		TY 35	
PFO1	7	0.77	5.39
PSS	14	0.58	8.12
PEMM	42	0.94	39.48
PEMS	0	0.00	0.00
RIV	2	0.94	1.88
STRIPPED AUG POOL	17	0.48	8.16
TOTAL	82		63.03
MEAN WEIGHTED HSI		0.77	
		TY 50	
PFO1	7	0.77	5.39
PSS	14	0.58	8.12
PEMM	42	0.94	39.48
PEMS	0	0.00	0.00
RIV	2	0.94	1.88
STRIPPED AUG POOL	17	0.48	8.16
TOTAL	82		63.03
MEAN WEIGHTED HSI		0.77	
		TY 100	
PFO1	7	0.77	5.39
PSS	14	0.58	8.12
PEMM	42	0.94	39.48
PEMS	0	0.00	0.00
RIV	2	0.94	1.88
STRIPPED AUG POOL	17	0.48	8.16
TOTAL	82		63.03
MEAN WEIGHTED HSI		0.77	

TABLE D-8: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR BLACK DUCK WITH PROJECT WITHOUT MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.39	25.35
PSS	62	0.31	19.22
PEMM	18	0.56	10.08
PEMS	10	0.60	6.00
TOTAL	155		60.65
MEAN WEIGHTED HSI		0.39	
		TY 1	
PFO1	7	0.39	2.73
PSS	11	0.20	2.20
PEMM	7	0.46	3.22
PEMS	0	0.00	0.00
TOTAL	25		8.15
MEAN WEIGHTED HSI		0.33	
		TY 10	
PFO1	7	0.39	2.73
PSS	14	0.24	3.36
PEMM	18	0.40	7.20
PEMS	0	0.00	0.00
TOTAL	39		13.29
MEAN WEIGHTED HSI		0.34	
		TY 35	
PFO1	7	0.39	2.73
PSS	14	0.24	3.36
PEMM	42	0.44	18.48
PEMS	0	0.00	0.00
TOTAL	63		24.57
MEAN WEIGHTED HSI		0.39	

TABLE D-8: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR BLACK DUCK WITH PROJECT WITHOUT MITIGATION (CONTINUED).

		TY 50	
PFO1	7	0.39	2.73
PSS	14	0.24	3.36
PEMM	42	0.44	18.48
PEMS	0	0.00	0.00
TOTAL	63		24.57
MEAN WEIGHTED HSI		0.39	
		TY 100	
PFO1	7	0.39	2.73
PSS	14	0.24	3.36
PEMM	42	0.44	18.48
PEMS	0	0.00	0.00
TOTAL	63		24.57
MEAN WEIGHTED HSI		0.39	

TABLE D-9: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR WOOD DUCK WITH PROJECT WITHOUT MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
HABITAT			
UFO1	384		
PFO1	65		
PSS	62		
PEMM	18		
PEMS	10		
RIV	13		
TOTAL	552	0.16	88.32
		TY 1	
HABITAT			
UFO1	361		
PFO1	7		
PSS	11		
PEMM	7		
PEMS	0		
RIV	2		
TOTAL	388	0.05	19.40
		TY 10	
HABITAT			
UFO1	325		
PFO1	7		
PSS	14		
PEMM	18		
PEMS	0		
RIV	2		
TOTAL	366	0.06	21.96
		TY 35	
HABITAT			
UFO1	235		
PFO1	7		
PSS	14		
PEMM	42		
PEMS	0		
RIV	2		
TOTAL	300	0.19	57.00

TABLE D-9: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR WOOD DUCK WITH PROJECT WITHOUT MITIGATION (CONTINUED).

		TY 50	
HABITAT			
UFO1	181		
PFO1	7		
PSS	14		
PEMM	42		
PEMS	0		
RIV	2		
TOTAL	246	0.22	54.12
		TY 100	
HABITAT			
UFO1	186		
PFO1	7		
PSS	14		
PEMM	42		
PEMS	0		
RIV	2		
TOTAL	251	0.21	52.71

TABLE D-10: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR BROAD-WINGED HAWK WITH PROJECT WITHOUT MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
HABITAT			
UFO1	384		
UFO4	77		
USS	17		
UF/G	25		
PFO1	65		
PFO4	23		
PSS	62		
TOTAL	653	1.00	653.00
		TY 1	
HABITAT			
UFO1	361		
UFO4	67		
USS	14		
UF/G	25		
PFO1	7		
PFO4	23		
PSS	11		
TOTAL	508	1.00	508.00
		TY 10	
HABITAT			
UFO1	325		
UFO4	104		
USS	36		
UF/G	24		
PFO1	7		
PFO4	23		
PSS	14		
TOTAL	533	1.00	533.00
		TY 35	
HABITAT			
UFO1	235		
UFO4	197		
USS	36		
UF/G	21		
PFO1	7		
PFO4	23		
PSS	14		
TOTAL	533	1.00	533.00

TABLE D-10: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR BROAD-WINGED HAWK WITH PROJECT WITHOUT MITIGATION (CONTINUED).

		TY 50	
HABITAT			
UFO1	181		
UFO4	252		
USS	36		
UF/G	20		
PFO1	7		
PFO4	23		
PSS	14		
TOTAL	533	1.00	533.00
		TY 100	
HABITAT			
UFO1	186		
UFO4	252		
USS	36		
UF/G	15		
PFO1	7		
PFO4	23		
PSS	14		
TOTAL	533	1.00	533.00

TABLE D-11: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR AMERICAN WOODCOCK WITH PROJECT WITHOUT MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
HABITAT			
UFO1	384		
PFO1	65		
PSS	62		
UF/G	25		
TOTAL	536	0.34	182.24
		TY 1	
HABITAT			
UFO1	361		
PFO1	7		
PSS	11		
UF/G	25		
TOTAL	404	0.45	181.80
		TY 10	
HABITAT			
UFO1	325		
PFO1	7		
PSS	14		
UF/G	24		
TOTAL	370	0.47	173.90
		TY 35	
HABITAT			
UFO1	235		
PFO1	7		
PSS	14		
UF/G	21		
TOTAL	277	0.55	152.35
		TY 50	
HABITAT			
UFO1	181		
PFO1	7		
PSS	14		
UF/G	20		
TOTAL	222	0.66	146.52

TABLE D-11: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR AMERICAN WOODCOCK WITH PROJECT WITHOUT MITIGATION (CONTINUED).

		TY 100	
HABITAT			
UFO1	186		
PFO1	7		
PSS	14		
UF/G	15		
TOTAL	222	0.49	108.78

TABLE D-12: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR BELTED KINGFISHER WITH PROJECT WITHOUT MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
RIV	13	0.96	12.48
PEMM	18	0.63	11.34
PEMS	10	0.38	3.80
PSS	62	0.08	4.96
PFO1	65	0.06	3.90
PFO4	23	0.00	0.00
TOTAL	191		36.48
MEAN WEIGHTED HSI		0.19	
		TY 1	
RIV	2	0.96	1.92
PEMM	7	0.63	4.41
PEMS	0	0.00	0.00
PSS	11	0.05	0.55
PFO1	7	0.06	0.42
PFO4	23	0.00	0.00
STRIPPED AUG POOL	17	0.00	0.00
PERM POOL	103	0.00	0.00
TOTAL	170		7.30
MEAN WEIGHTED HSI		0.04	
		TY 10	
RIV	2	0.96	1.92
PEMM	18	0.50	9.00
PEMS	0	0.00	0.00
PSS	14	0.06	0.84
PFO1	7	0.06	0.42
PFO4	23	0.00	0.00
STRIPPED AUG POOL	17	0.55	9.35
PERM POOL	103	0.77	79.31
TOTAL	184		100.84
MEAN WEIGHTED HSI		0.55	

TABLE D-12: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR BELTED KINGFISHER WITH PROJECT WITHOUT MITIGATION (CONTINUED).

	TY 35		
RIV	2	0.96	1.92
PEMM	42	0.51	21.42
PEMS	0	0.00	0.00
PSS	14	0.06	0.84
PFO1	7	0.06	0.42
PFO4	23	0.00	0.00
STRIPPED AUG POOL	17	0.55	9.35
PERM POOL	103	0.77	79.31
TOTAL	208		113.26
MEAN WEIGHTED HSI		0.54	
	TY 50		
RIV	2	0.96	1.92
PEMM	42	0.51	21.42
PEMS	0	0.00	0.00
PSS	14	0.06	0.84
PFO1	7	0.06	0.42
PFO4	23	0.00	0.00
STRIPPED AUG POOL	17	0.55	9.35
PERM POOL	103	0.77	79.31
TOTAL	208		113.26
MEAN WEIGHTED HSI		0.54	
	TY 100		
RIV	2	0.96	1.92
PEMM	42	0.51	21.42
PEMS	0	0.00	0.00
PSS	14	0.06	0.84
PFO1	7	0.06	0.42
PFO4	23	0.00	0.00
STRIPPED AUG POOL	17	0.55	9.35
PERM POOL	103	0.77	79.31
TOTAL	208		113.26
MEAN WEIGHTED HSI		0.54	

TABLE D-13: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR DOWNY WOODPECKER WITH PROJECT WITHOUT MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.96	62.40
PFO4	23	0.33	7.59
UFO1	384	0.81	311.04
UFO4	77	0.48	36.96
TOTAL	549		417.99
MEAN WEIGHTED HSI		0.76	
		TY 1	
PFO1	7	0.96	6.72
PFO4	23	0.33	7.59
UFO1	361	0.81	292.41
UFO4	67	0.48	32.16
TOTAL	458		338.88
MEAN WEIGHTED HSI		0.74	
		TY 10	
PFO1	7	0.96	6.72
PFO4	23	0.33	7.59
UFO1	325	0.81	263.25
UFO4	104	0.48	49.92
TOTAL	459		327.48
MEAN WEIGHTED HSI		0.71	
		TY 35	
PFO1	7	0.96	6.72
PFO4	23	0.33	7.59
UFO1	235	0.81	190.35
UFO4	197	0.48	94.56
TOTAL	462		299.22
MEAN WEIGHTED HSI		0.65	

TABLE D-13: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR DOWNY WOODPECKER WITH PROJECT WITHOUT MITIGATION (CONTINUED).

		TY 50	
PFO1	7	0.96	6.72
PFO4	23	0.33	7.59
UFO1	181	0.81	146.61
UFO4	252	0.48	120.96
TOTAL	463		281.88
MEAN WEIGHTED HSI		0.61	
		TY 100	
PFO1	7	0.96	6.72
PFO4	23	0.33	7.59
UFO1	186	0.81	150.66
UFO4	252	0.48	120.96
TOTAL	468		285.93
MEAN WEIGHTED HSI		0.61	

TABLE D-14: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR YELLOW WARBLER WITH PROJECT WITHOUT MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PSS	62	0.50	31.00
USS	17	0.49	8.33
TOTAL	79		39.33
MEAN WEIGHTED HSI		0.50	
		TY 1	
PSS	11	0.38	4.18
USS	14	0.49	6.86
TOTAL	25		11.04
MEAN WEIGHTED HSI		0.44	
		TY 10	
PSS	14	0.42	5.88
USS	36	0.49	17.64
TOTAL	50		23.52
MEAN WEIGHTED HSI		0.47	
		TY 35	
PSS	14	0.42	5.88
USS	36	0.49	17.64
TOTAL	50		23.52
MEAN WEIGHTED HSI		0.47	

TABLE D-14: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR YELLOW WARBLER WITH PROJECT WITHOUT MITIGATION (CONTINUED).

	TY 50		
PSS	14	0.42	5.88
USS	36	0.49	17.64
TOTAL	50		23.52
MEAN WEIGHTED HSI		0.47	
	TY 100		
PSS	14	0.42	5.88
USS	36	0.49	17.64
TOTAL	50		23.52
MEAN WEIGHTED HSI		0.47	

TABLE D-15: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR SWAMP SPARROW WITH PROJECT WITHOUT MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.54	35.10
PSS	62	0.80	49.60
PEMM	18	0.80	14.40
PEMS	10	0.90	9.00
PFO4	23	0.48	11.04
TOTAL	178		119.14
MEAN WEIGHTED HSI		0.67	
		TY 1	
PFO1	7	0.54	3.78
PSS	11	0.66	7.26
PEMM	7	0.80	5.60
PEMS	0	0.00	0.00
PFO4	23	0.48	11.04
TOTAL	48		27.68
MEAN WEIGHTED HSI		0.58	
		TY 10	
PFO1	7	0.54	3.78
PSS	14	0.71	9.94
PEMM	18	0.80	14.40
PEMS	0	0.00	0.00
PFO4	23	0.48	11.04
TOTAL	62		39.16
MEAN WEIGHTED HSI		0.63	

TABLE D-15: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREAS (ACRES) FOR SWAMP SPARROW WITH PROJECT WITHOUT MITIGATION (CONTINUED).

		TY 35	
PFO1	7	0.54	3.78
PSS	14	0.71	9.94
PEMM	42	0.80	33.60
PEMS	0	0.00	0.00
PFO4	23	0.48	11.04
TOTAL	86		58.36
MEAN WEIGHTED HSI		0.68	
		TY 50	
PFO1	7	0.54	3.78
PSS	14	0.71	9.94
PEMM	42	0.80	33.60
PEMS	0	0.00	0.00
PFO4	23	0.48	11.04
TOTAL	86		58.36
MEAN WEIGHTED HSI		0.68	
		TY 100	
PFO1	7	0.54	3.78
PSS	14	0.71	9.94
PEMM	42	0.80	33.60
PEMS	0	0.00	0.00
PFO4	23	0.48	11.04
TOTAL	86		58.36
MEAN WEIGHTED HSI		0.68	

APPENDIX E
BASELINE AND PROJECTED HABITAT UNITS
WITH PROJECT IMPLEMENTATION
WITH MITIGATION

TABLE E-1: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR RED-BACKED VOLE WITH PROJECT WITH MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.57	37.05
UFO1	384	0.26	99.84
PSS	62	0.30	18.60
USS	17	0.24	4.08
TOTAL	528		159.57
MEAN WEIGHTED HSI		0.30	
		TY 1	
PFO1	7	0.57	3.99
UFO1	361	0.26	93.86
PSS	11	0.11	1.21
USS	14	0.24	3.36
PSS-PENINSULA	5	0.00	0.00
TOTAL	398		102.42
MEAN WEIGHTED HSI		0.26	
		TY 10	
PFO1	7	0.57	3.99
UFO1	329	0.32	105.28
PSS	14	0.18	2.52
USS	45	0.24	10.80
PSS-PENINSULA	5	0.42	2.10
TOTAL	400		124.69
MEAN WEIGHTED HSI		0.31	

TABLE E-1: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR RED-BACKED VOLE WITH PROJECT WITH MITIGATION (CONTINUED).

		TY 35	
PFO1	7	0.57	3.99
UFO1	296	0.45	133.20
PSS	14	0.18	2.52
USS	36	0.24	8.64
PSS-PENINSULA	5	0.42	2.10
TOTAL	358		150.45
MEAN WEIGHTED HSI		0.42	
		TY 50	
PFO1	7	0.57	3.99
UFO1	271	0.51	138.21
PSS	14	0.18	2.52
USS	36	0.24	8.64
PSS-PENINSULA	5	0.42	2.10
TOTAL	333		155.46
MEAN WEIGHTED HSI		0.47	
		TY 100	
PFO1	7	0.57	3.99
UFO1	271	0.51	138.21
PSS	14	0.18	2.52
USS	36	0.24	8.64
PSS-PENINSULA	5	0.42	2.10
TOTAL	333		155.46
MEAN WEIGHTED HSI		0.47	

TABLE E-2: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR MINK WITH PROJECT WITH MITIGATION.

Cover Type	Area + Upland Habitat	Mean HSI	Habitat Units
		TY 0	
PF01	175	0.89	155.75
PF04	38	0.50	19.00
PSS	165	0.77	127.05
PEMM	38	1.00	38.00
PEMS	11	0.94	10.34
RIV	39	1.00	39.00
TOTAL	466		389.14
MEAN WEIGHTED HSI		0.84	
		TY 1	
PF01	36	0.89	32.04
PF04	38	0.50	19.00
PSS	28	0.91	25.48
PEMM	24	1.00	24.00
PEMS	0	0.00	0.00
RIV	6	1.00	6.00
PERM POOL + UPLAND	199	0.00	0.00
MARSH	89	0.00	0.00
ISLAND & PENINSULA	25	0.00	0.00
TOTAL	445		106.52
MEAN WEIGHTED HSI		0.24	

TABLE E-2: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR MINK WITH PROJECT WITH MITIGATION (CONTINUED).

		TY 10	
PFO1	36	0.89	32.04
PFO4	38	0.50	19.00
PSS	31	0.86	26.66
PEMM	24	1.00	24.00
PEMS	0	0.00	0.00
RIV	6	1.00	6.00
PERM POOL + UPLAND	199	0.99	197.01
MARSH	89	0.26	23.14
ISLAND & PENINSULA	25	0.57	14.25
TOTAL	448		342.10
MEAN WEIGHTED HSI		0.76	
		TY 35	
PFO1	36	0.89	32.04
PFO4	38	0.50	19.00
PSS	31	0.86	26.66
PEMM	24	1.00	24.00
PEMS	0	0.00	0.00
RIV	6	1.00	6.00
PERM POOL + UPLAND	199	0.99	197.01
MARSH	89	1.00	89.00
ISLAND & PENINSULA	25	0.57	14.25
TOTAL	448		407.96
MEAN WEIGHTED HSI		0.91	

TABLE E-2: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR MINK WITH PROJECT WITH MITIGATION (CONTINUED).

		TY 50	
PF01	36	0.89	32.04
PF04	38	0.50	19.00
PSS	31	0.86	26.66
PEMM	24	1.00	24.00
PEMS	0	0.00	0.00
RIV	6	1.00	6.00
PERM POOL + UPLAND	199	0.99	197.01
MARSH	89	1.00	89.00
ISLAND & PENINSULA	25	0.57	14.25
TOTAL	448		407.96
MEAN WEIGHTED HSI		0.91	
		TY 100	
PF01	36	0.89	32.04
PF04	38	0.50	19.00
PSS	31	0.86	26.66
PEMM	24	1.00	24.00
PEMS	0	0.00	0.00
RIV	6	1.00	6.00
PERM POOL + UPLAND	199	0.99	197.01
MARSH	89	1.00	89.00
ISLAND & PENINSULA	25	0.57	14.25
TOTAL	448		407.96
MEAN WEIGHTED HSI		0.91	

TABLE E-3: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR MUSKRAT WITH PROJECT WITH MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
RIV	13	0.51	6.63
PEMM	18	0.63	11.34
PEMS	10	0.20	2.00
TOTAL	41		19.97
MEAN WEIGHTED HSI		0.49	
		TY 1	
RIV	2	0.51	1.02
PEMM	7	0.63	4.41
PEMS	0	0.00	0.00
MARSH	35	0.00	0.00
ISLAND & PENINSULA	25	0.00	0.00
TOTAL	69		5.43
MEAN WEIGHTED HSI		0.08	
		TY 10	
RIV	2	0.51	1.02
PEMM	7	0.66	4.62
PEMS	0	0.00	0.00
MARSH	35	0.19	6.65
ISLAND & PENINSULA	25	0.45	11.25
TOTAL	69		23.54
MEAN WEIGHTED HSI		0.34	

TABLE E-3: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR MUSKRAT WITH PROJECT WITH MITIGATION (CONTINUED).

		TY35	
RIV	2	0.51	1.02
PEMM	7	0.72	5.04
PEMS	0	0.00	0.00
MARSH	35	0.71	24.85
ISLAND & PENINSULA	25	0.45	11.25
TOTAL	69		42.16
MEAN WEIGHTED HSI		0.61	
		TY 50	
RIV	2	0.51	1.02
PEMM	7	0.76	5.32
PEMS	0	0.00	0.00
MARSH	35	0.71	24.85
ISLAND & PENINSULA	25	0.45	11.25
TOTAL	69		42.44
MEAN WEIGHTED HSI		0.62	
		TY 100	
RIV	2	0.51	1.02
PEMM	7	0.76	5.32
PEMS	0	0.00	0.00
MARSH	35	0.71	24.85
ISLAND & PENINSULA	25	0.45	11.25
TOTAL	69		42.44
MEAN WEIGHTED HSI		0.62	

TABLE E-4: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR DUSKY SALAMANDER WITH PROJECT WITH MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.65	42.25
PFO4	23	0.55	12.65
PSS	62	0.53	32.86
RIV	13	0.77	10.01
UFO1	384	0.01	3.84
UFO4	77	0.06	4.62
TOTAL	624		106.23
MEAN WEIGHTED HSI		0.17	
		TY 1	
PFO1	7	0.65	4.55
PFO4	23	0.55	12.65
PSS	11	0.67	7.37
RIV	2	0.77	1.54
UFO1	361	0.01	3.61
UFO4	67	0.06	4.02
PSS-ISLAND & PENINSULA	8	0.00	0.00
TOTAL	479		33.74
MEAN WEIGHTED HSI		0.07	
		TY 10	
PFO1	7	0.65	4.55
PFO4	23	0.55	12.65
PSS	14	0.62	8.68
RIV	2	0.77	1.54
UFO1	329	0.01	3.29
UFO4	84	0.06	5.04
PSS-ISLAND & PENINSULA	8	0.60	4.80
TOTAL	467		40.55
MEAN WEIGHTED HSI		0.09	

TABLE E-4: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR DUSKY SALAMANDER WITH PROJECT WITH MITIGATION (CONTINUED).

		TY 35	
PFO1	7	0.65	4.55
PFO4	23	0.55	12.65
PSS	14	0.62	8.68
RIV	2	0.77	1.54
UFO1	296	0.01	2.96
UFO4	136	0.06	8.16
PSS-ISLAND & PENINSULA	8	0.60	4.80
TOTAL	486		43.34
MEAN WEIGHTED HSI		0.09	
		TY 50	
PFO1	7	0.65	4.55
PFO4	23	0.55	12.65
PSS	14	0.62	8.68
RIV	2	0.77	1.54
UFO1	271	0.01	2.71
UFO4	161	0.06	9.66
PSS-ISLAND & PENINSULA	8	0.60	4.80
TOTAL	486		44.59
MEAN WEIGHTED HSI		0.09	
		TY 100	
PFO1	7	0.65	4.55
PFO4	23	0.55	12.65
PSS	14	0.62	8.68
RIV	2	0.77	1.54
UFO1	271	0.01	2.71
UFO4	161	0.06	9.66
PSS-ISLAND & PENINSULA	8	0.60	4.80
TOTAL	486		44.59
MEAN WEIGHTED HSI		0.09	

TABLE E-5: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR WOOD FROG WITH PROJECT WITH MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.95	61.75
UFO1	384	0.81	311.04
TOTAL	449		372.79
MEAN WEIGHTED HSI		0.83	
		TY 1	
PFO1	7	0.95	6.65
UFO1	361	0.81	292.41
TOTAL	368		299.06
MEAN WEIGHTED HSI		0.81	
		TY 10	
PFO1	7	0.95	6.65
UFO1	329	0.81	266.49
TOTAL	336		273.14
MEAN WEIGHTED HSI		0.81	
		TY 35	
PFO1	7	0.95	6.65
UFO1	296	0.81	239.76
TOTAL	303		246.41
MEAN WEIGHTED HSI		0.81	

TABLE E-5: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR WOOD FROG WITH PROJECT WITH MITIGATION (CONTINUED).

		TY 50	
PFO1	7	0.95	6.65
UFO1	271	0.81	219.51
TOTAL	278		226.16
MEAN WEIGHTED HSI		0.81	
		TY 100	
PFO1	7	0.95	6.65
UFO1	271	0.81	219.51
TOTAL	278		226.16
MEAN WEIGHTED HSI		0.81	

TABLE E-6: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR SNAPPING TURTLE WITH PROJECT WITH MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.00	0.00
PSS	62	0.24	14.88
PEMM	18	0.93	16.74
PEMS	10	0.00	0.00
RIV	13	0.17	2.21
TOTAL	168		33.83
MEAN WEIGHTED HSI		0.20	
		TY 1	
PFO1	7	0.00	0.00
PSS	11	0.09	0.99
PEMM	7	0.93	6.51
PEMS	0	0.00	0.00
RIV	2	0.17	0.34
PERM POOL	88	0.00	0.00
MARSH	35	0.00	0.00
ISLAND & PENINSULA	25	0.00	0.00
TOTAL	175		7.84
MEAN WEIGHTED HSI		0.04	
		TY 10	
PFO1	7	0.00	0.00
PSS	14	0.14	1.96
PEMM	7	0.93	6.51
PEMS	0	0.00	0.00
RIV	2	0.17	0.34
PERM POOL	88	0.05	4.40
MARSH	35	0.78	27.30
ISLAND & PENINSULA	25	0.55	13.75
TOTAL	178		54.26
MEAN WEIGHTED HSI		0.30	

TABLE E-6: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR SNAPPING TURTLE WITH PROJECT WITH MITIGATION (CONTINUED).

		TY 35	
PFO1	7	0.00	0.00
PSS	14	0.14	1.96
PEMM	7	0.93	6.51
PEMS	0	0.00	0.00
RIV	2	0.17	0.34
PERM POOL	88	0.15	13.20
MARSH	35	0.93	32.55
ISLAND & PENINSULA	25	0.55	13.75
TOTAL	178		68.31
MEAN WEIGHTED HSI		0.38	
		TY 50	
PFO1	7	0.00	0.00
PSS	14	0.14	1.96
PEMM	7	0.93	6.51
PEMS	0	0.00	0.00
RIV	2	0.17	0.34
PERM POOL	88	0.21	18.48
MARSH	35	0.93	32.55
ISLAND & PENINSULA	25	0.55	13.75
TOTAL	178		73.59
MEAN WEIGHTED HSI		0.41	
		TY 100	
PFO1	7	0.00	0.00
PSS	14	0.14	1.96
PEMM	7	0.93	6.51
PEMS	0	0.00	0.00
RIV	2	0.17	0.34
PERM POOL	88	0.42	36.96
MARSH	35	0.93	32.55
ISLAND & PENINSULA	25	0.55	13.75
TOTAL	178		92.07
MEAN WEIGHTED HSI		0.52	

TABLE E-7: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR GREEN HERON WITH PROJECT WITH MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.77	50.05
PSS	62	0.64	39.68
PEMM	18	1.00	18.00
PEMS	10	0.77	7.70
RIV	13	0.94	12.22
TOTAL	168		127.65
MEAN WEIGHTED HSI		0.76	
		TY 1	
PFO1	7	0.77	5.39
PSS	11	0.55	6.05
PEMM	7	1.00	7.00
PEMS	0	0.00	0.00
RIV	2	0.94	1.88
STRIPPED AUG POOL	7	0.00	0.00
MARSH	35	0.00	0.00
ISLAND & PENINSULA	25	0.00	0.00
TOTAL	94		20.32
MEAN WEIGHTED HSI		0.22	
		TY 10	
PFO1	7	0.77	5.39
PSS	14	0.58	8.12
PEMM	7	1.00	7.00
PEMS	0	0.00	0.00
RIV	2	0.94	1.88
STRIPPED AUG POOL	7	0.48	3.36
MARSH	35	0.26	9.10
ISLAND & PENINSULA	25	0.96	24.00
TOTAL	97		58.85
MEAN WEIGHTED HSI		0.61	

TABLE E-7: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR GREEN HERON WITH PROJECT WITH MITIGATION (CONTINUED).

		TY 35	
PFO1	7	0.77	5.39
PSS	14	0.58	8.12
PEMM	7	1.00	7.00
PEMS	0	0.00	0.00
RIV	2	0.94	1.88
STRIPPED AUG POOL	7	0.48	3.36
MARSH	35	0.98	34.30
ISLAND & PENINSULA	25	0.96	24.00
TOTAL	97		84.05
MEAN WEIGHTED HSI		0.87	
		TY 50	
PFO1	7	0.77	5.39
PSS	14	0.58	8.12
PEMM	7	1.00	7.00
PEMS	0	0.00	0.00
RIV	2	0.94	1.88
STRIPPED AUG POOL	7	0.48	3.36
MARSH	35	0.98	34.30
ISLAND & PENINSULA	25	0.96	24.00
TOTAL	97		84.05
MEAN WEIGHTED HSI		0.87	

TABLE E-7: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR GREEN HERON WITH PROJECT WITH MITIGATION (CONTINUED).

	TY 100		
PFO1	7	0.77	5.39
PSS	14	0.58	8.12
PEMM	7	1.00	7.00
PEMS	0	0.00	0.00
RIV	2	0.94	1.88
STRIPPED AUG POOL	7	0.48	3.36
MARSH	35	0.98	34.30
ISLAND & PENINSULA	25	0.96	24.00
TOTAL	97		84.05
MEAN WEIGHTED HSI		0.87	

TABLE E-8: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR BLACK DUCK WITH PROJECT WITH MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.39	25.35
PSS	62	0.31	19.22
PEMM	18	0.56	10.08
PEMS	10	0.60	6.00
TOTAL	155		60.65
MEAN WEIGHTED HSI		0.39	
		TY 1	
PFO1	7	0.39	2.73
PSS	11	0.20	2.20
PEMM	7	0.46	3.22
PEMS	0	0.00	0.00
MARSH	35	0.00	0.00
ISLAND	10	0.00	0.00
PENINSULA	15	0.00	0.00
TOTAL	85		8.15
MEAN WEIGHTED HSI		0.10	
		TY 10	
PFO1	7	0.39	2.73
PSS	14	0.24	3.36
PEMM	7	0.46	3.22
PEMS	0	0.00	0.00
MARSH	35	0.16	5.60
ISLAND	10	0.47	4.70
PENINSULA	15	0.53	7.95
TOTAL	88		27.56
MEAN WEIGHTED HSI		0.31	

TABLE E-8: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR BLACK DUCK WITH PROJECT WITH MITIGATION (CONTINUED).

		TY 35	
PFO1	7	0.39	2.73
PSS	14	0.24	3.36
PEMM	7	0.46	3.22
PEMS	0	0.00	0.00
MARSH	35	0.62	21.70
ISLAND	10	0.47	4.70
PENINSULA	15	0.53	7.95
TOTAL	88		43.66
MEAN WEIGHTED HSI		0.50	
		TY 50	
PFO1	7	0.39	2.73
PSS	14	0.24	3.36
PEMM	7	0.46	3.22
PEMS	0	0.00	0.00
MARSH	35	0.62	21.70
ISLAND	10	0.47	4.70
PENINSULA	15	0.53	7.95
TOTAL	88		43.66
MEAN WEIGHTED HSI		0.50	
		TY 100	
PFO1	7	0.39	2.73
PSS	14	0.24	3.36
PEMM	7	0.46	3.22
PEMS	0	0.00	0.00
MARSH	35	0.62	21.70
ISLAND	10	0.47	4.70
PENINSULA	15	0.53	7.95
TOTAL	88		43.66
MEAN WEIGHTED HSI		0.50	

TABLE E-9: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR WOOD DUCK WITH PROJECT WITH MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
HABITAT			
UFO1	384		
PFO1	65		
PSS	62		
PEMM	18		
PEMS	10		
RIV	13		
TOTAL	552	0.16	88.32
		TY 1	
HABITAT			
UFO1	361		
PFO1	7		
PSS	11		
PEMM	7		
PEMS	0		
RIV	2		
MARSH	35		
ISLAND & PENINSULA	25		
TOTAL	448	0.04	17.92
		TY 10	
HABITAT			
UFO1	329		
PFO1	7		
PSS	14		
PEMM	7		
PEMS	0		
RIV	2		
MARSH	35		
ISLAND & PENINSULA	25		
TOTAL	419	0.16	67.04

TABLE E-9: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR WOOD DUCK WITH PROJECT WITH MITIGATION (CONTINUED).

		TY 35	
HABITAT			
UFO1	296		
PFO1	7		
PSS	14		
PEMM	7		
PEMS	0		
RIV	2		
MARSH	35		
ISLAND & PENINSULA	25		
TOTAL	386	0.20	77.20
		TY 50	
HABITAT			
UFO1	271		
PFO1	7		
PSS	14		
PEMM	7		
PEMS	0		
RIV	2		
MARSH	35		
ISLAND & PENINSULA	25		
TOTAL	361	0.21	75.81
		TY 100	
HABITAT			
UFO1	271		
PFO1	7		
PSS	14		
PEMM	7		
PEMS	0		
RIV	2		
MARSH	35		
ISLAND & PENINSULA	25		
TOTAL	361	0.21	75.81

TABLE E-10: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR BROAD-WINGED HAWK WITH PROJECT WITH MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
HABITAT			
UF01	384		
UF04	77		
USS	17		
UF/G	25		
PF01	65		
PF04	23		
PSS	62		
TOTAL	653	1.00	653.00
		TY 1	
HABITAT			
UF01	361		
UF04	67		
USS	14		
UF/G	25		
PF01	7		
PF04	23		
PSS	11		
PSS-ISLAND & PENINSULA	8		
TOTAL	516	1.00	516.00
		TY 10	
HABITAT			
UF01	329		
UF04	84		
USS	45		
UF/G	40		
PF01	7		
PF04	23		
PSS	14		
PSS-ISLAND & PENINSULA	8		
TOTAL	550	1.00	550.00

TABLE E-10: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR BROAD-WINGED HAWK WITH PROJECT WITH MITIGATION (CONTINUED).

		TY 35	
HABITAT			
UFO1	296		
UFO4	136		
USS	36		
UF/G	30		
PFO1	7		
PFO4	23		
PSS	14		
PSS-ISLAND & PENINSULA	8		
TOTAL	550	1.00	550.00
		TY 50	
HABITAT			
UFO1	271		
UFO4	161		
USS	36		
UF/G	30		
PFO1	7		
PFO4	23		
PSS	14		
PSS-ISLAND & PENINSULA	8		
TOTAL	550	1.00	550.00
		TY 100	
HABITAT			
UFO1	271		
UFO4	161		
USS	36		
UF/G	30		
PFO1	7		
PFO4	23		
PSS	14		
PSS-ISLAND & PENINSULA	8		
TOTAL	550	1.00	550.00

TABLE E-11: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR AMERICAN WOODCOCK WITH PROJECT WITH MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
HABITAT			
UFO1	384		
PFO1	65		
PSS	62		
UF/G	25		
TOTAL	536	0.34	182.24
		TY 1	
HABITAT			
UFO1	361		
PFO1	7		
PSS	11		
UF/G	25		
PSS-ISLAND & PENINSULA	8		
TOTAL	412	0.45	185.40
		TY 10	
HABITAT			
UFO1	329		
PFO1	7		
PSS	14		
UF/G	40		
PSS-ISLAND & PENINSULA	8		
TOTAL	398	0.74	294.52
		TY 35	
HABITAT			
UFO1	296		
PFO1	7		
PSS	14		
UF/G	30		
PSS-ISLAND & PENINSULA	8		
TOTAL	355	0.62	220.10

TABLE E-11: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR AMERICAN WOODCOCK WITH PROJECT WITH MITIGATION (CONTINUED).

		TY 50	
HABITAT			
UFO1	271		
PFO1	7		
PSS	14		
UF/G	30		
PSS-ISLAND & PENINSULA	8		
TOTAL	330	0.66	217.80
		TY 100	
HABITAT			
UFO1	271		
PFO1	7		
PSS	14		
UF/G	30		
PSS-ISLAND & PENINSULA	8		
TOTAL	330	0.66	217.80

TABLE E-12: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR BELTED KINGFISHER WITH PROJECT WITH MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
RIV	13	0.96	12.48
PEMM	18	0.63	11.34
PEMS	10	0.38	3.80
PSS	62	0.08	4.96
PFO1	65	0.06	3.90
PFO4	23	0.00	0.00
TOTAL	191		36.48
MEAN WEIGHTED HSI		0.19	
		TY 1	
RIV	2	0.96	1.92
PEMM	7	0.63	4.41
PEMS	0	0.00	0.00
PSS	11	0.05	0.55
PFO1	7	0.06	0.42
PFO4	23	0.00	0.00
STRIPPED AUG POOL	7	0.00	0.00
PERM POOL	88	0.00	0.00
MARSH	35	0.00	0.00
ISLAND & PENINSULA	25	0.00	0.00
TOTAL	205		7.30
MEAN WEIGHTED HSI		0.04	

TABLE E-12: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR BELTED KINGFISHER WITH PROJECT WITH MITIGATION (CONTINUED).

		TY 10	
RIV	2	0.96	1.92
PEMM	7	0.63	4.41
PEMS	0	0.00	0.00
PSS	14	0.06	0.84
PFO1	7	0.06	0.42
PFO4	23	0.00	0.00
STRIPPED AUG POOL	7	0.55	3.85
PERM POOL	88	0.77	67.76
MARSH	35	0.13	4.55
ISLAND & PENINSULA	25	0.13	3.25
TOTAL	208		87.00
MEAN WEIGHTED HSI		0.42	
		TY 35	
RIV	2	0.96	1.92
PEMM	7	0.63	4.41
PEMS	0	0.00	0.00
PSS	14	0.06	0.84
PFO1	7	0.06	0.42
PFO4	23	0.00	0.00
STRIPPED AUG POOL	7	0.55	3.85
PERM POOL	88	0.77	67.76
MARSH	35	0.49	17.15
ISLAND & PENINSULA	25	0.49	12.25
TOTAL	208		108.60
MEAN WEIGHTED HSI		0.52	

TABLE E-12: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR BELTED KINGFISHER WITH PROJECT WITH MITIGATION (CONTINUED).

		TY 50	
RIV	2	0.96	1.92
PEMM	7	0.63	4.41
PEMS	0	0.00	0.00
PSS	14	0.06	0.84
PFO1	7	0.06	0.42
PFO4	23	0.00	0.00
STRIPPED AUG POOL	7	0.55	3.85
PERM POOL	88	0.77	67.76
MARSH	35	0.49	17.15
ISLAND & PENINSULA	25	0.49	12.25
TOTAL	208		108.60
MEAN WEIGHTED HSI		0.52	
		TY 100	
RIV	2	0.96	1.92
PEMM	7	0.63	4.41
PEMS	0	0.00	0.00
PSS	14	0.06	0.84
PFO1	7	0.06	0.42
PFO4	23	0.00	0.00
STRIPPED AUG POOL	7	0.55	3.85
PERM POOL	88	0.77	67.76
MARSH	35	0.49	17.15
ISLAND & PENINSULA	25	0.49	12.25
TOTAL	208		108.60
MEAN WEIGHTED HSI		0.52	

TABLE E-13: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR DOWNY WOODPECKER WITH PROJECT WITH MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.96	62.40
PFO4	23	0.33	7.59
UFO1	384	0.81	311.04
UFO4	77	0.48	36.96
TOTAL	549		417.99
MEAN WEIGHTED HSI		0.76	
		TY 1	
PFO1	7	0.96	6.72
PFO4	23	0.33	7.59
UFO1	361	0.81	292.41
UFO4	67	0.48	32.16
TOTAL	458		338.88
MEAN WEIGHTED HSI		0.74	
		TY 10	
PFO1	7	0.96	6.72
PFO4	23	0.33	7.59
UFO1	329	0.81	266.49
UFO4	84	0.55	46.20
TOTAL	443		327.00
MEAN WEIGHTED HSI		0.74	
		TY 35	
PFO1	7	0.96	6.72
PFO4	23	0.33	7.59
UFO1	296	0.81	239.76
UFO4	136	0.71	96.56
TOTAL	462		350.63
MEAN WEIGHTED HSI		0.76	

TABLE E-13: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR DOWNY WOODPECKER WITH PROJECT WITH MITIGATION (CONTINUED).

		TY 50	
PFO1	7	0.96	6.72
PFO4	23	0.33	7.59
UFO1	271	0.81	219.51
UFO4	161	0.81	130.41
TOTAL	462		364.23
MEAN WEIGHTED HSI		0.79	
		TY 100	
PFO1	7	0.96	6.72
PFO4	23	0.33	7.59
UFO1	271	0.81	219.51
UFO4	161	0.81	130.41
TOTAL	462		364.23
MEAN WEIGHTED HSI		0.79	

TABLE E-14: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR YELLOW WARBLER WITH PROJECT WITH MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PSS	62	0.50	31.00
USS	17	0.49	8.33
TOTAL	79		39.33
MEAN WEIGHTED HSI		0.50	
		TY 1	
PSS	11	0.38	4.18
USS	14	0.49	6.86
PSS-ISLAND & PENINSULA	8	0.00	0.00
TOTAL	33		11.04
MEAN WEIGHTED HSI		0.33	
		TY 10	
PSS	14	0.42	5.88
USS	45	0.49	22.05
PSS-ISLAND & PENINSULA	8	0.87	6.96
TOTAL	67		34.89
MEAN WEIGHTED HSI		0.52	
		TY 35	
PSS	14	0.42	5.88
USS	36	0.49	17.64
PSS-ISLAND & PENINSULA	8	0.87	6.96
TOTAL	58		30.48
MEAN WEIGHTED HSI		0.53	

TABLE E-14: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR YELLOW WARBLER WITH PROJECT WITH MITIGATION (CONTINUED).

		TY 50	
PSS	14	0.42	5.88
USS	36	0.49	17.64
PSS-ISLAND & PENINSULA	8	0.87	6.96
TOTAL	58		30.48
MEAN WEIGHTED HSI		0.53	
		TY 100	
PSS	14	0.42	5.88
USS	36	0.49	17.64
PSS-ISLAND & PENINSULA	8	0.87	6.96
TOTAL	58		30.48
MEAN WEIGHTED HSI		0.53	

TABLE E-15: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR SWAMP SPARROW WITH PROJECT WITH MITIGATION.

Cover Type	Area	Mean HSI	Habitat Units
		TY 0	
PFO1	65	0.54	35.10
PSS	62	0.80	49.60
PEMM	18	0.80	14.40
PEMS	10	0.90	9.00
PFO4	23	0.48	11.04
TOTAL	178		119.14
MEAN WEIGHTED HSI		0.67	
		TY 1	
PFO1	7	0.54	3.78
PSS	11	0.66	7.26
PEMM	7	0.80	5.60
PEMS	0	0.00	0.00
PFO4	23	0.48	11.04
MARSH	35	0.00	0.00
ISLAND & PENINSULA	25	0.00	0.00
TOTAL	108		27.68
MEAN WEIGHTED HSI		0.26	
		TY 10	
PFO1	7	0.54	3.78
PSS	14	0.71	9.94
PEMM	7	0.80	5.60
PEMS	0	0.00	0.00
PFO4	23	0.48	11.04
MARSH	35	0.21	7.35
ISLAND & PENINSULA	25	0.78	19.50
TOTAL	111		57.21
MEAN WEIGHTED HSI		0.52	

TABLE E-15: BASELINE AND PROJECTED HABITAT UNITS, MEAN HSI VALUES, AND HABITAT AREA (ACRES) FOR SWAMP SPARROW WITH PROJECT WITH MITIGATION (CONTINUED).

		TY 35	
PFO1	7	0.54	3.78
PSS	14	0.71	9.94
PEMM	7	0.80	5.60
PEMS	0	0.00	0.00
PFO4	23	0.48	11.04
MARSH	35	0.80	28.00
ISLAND & PENINSULA	25	0.78	19.50
TOTAL	111		77.86
MEAN WEIGHTED HSI		0.70	
		TY 50	
PFO1	7	0.54	3.78
PSS	14	0.71	9.94
PEMM	7	0.80	5.60
PEMS	0	0.00	0.00
PFO4	23	0.48	11.04
MARSH	35	0.80	28.00
ISLAND & PENINSULA	25	0.78	19.50
TOTAL	111		77.86
MEAN WEIGHTED HSI		0.70	
		TY 100	
PFO1	7	0.54	3.78
PSS	14	0.71	9.94
PEMM	7	0.80	5.60
PEMS	0	0.00	0.00
PFO4	23	0.48	11.04
MARSH	35	0.80	28.00
ISLAND & PENINSULA	25	0.78	19.50
TOTAL	111		77.86
MEAN WEIGHTED HSI		0.70	

APPENDIX B

HABITAT EVALUATION PROCEDURE (HEP)
ANALYSIS OF THE FRENCH RIVER WARM WATER FISHERY

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HABITAT EVALUATION PROCEDURE (HEP)
ANALYSIS OF THE FRENCH RIVER WARM WATER FISHERY

APPENDIX B

I. INTRODUCTION

The proposed project would have impacts on the existing fisheries of the French River. The upstream riverine habitat would be dredged and replaced with a permanent and augmentation pool. The low flows during summer would be augmented to 10 cubic feet/sec (cfs) and change certain conditions downstream of the site. To assess to what changes are occurring and how they would impact on the French River's fish populations, a Habitat Evaluation Procedure (HEP) study was developed. The procedures used in this study has been outlined in Ecological Services Manual (ESM) 102, 103 (U.S. Fish and Wildlife Service 1980, 1981) and Terrell et al. (1982). For a clear understanding of the study process described below, the reader is encouraged to review these documents prior to reading this Appendix.

II. STUDY PREPARATION:

A. STUDY LIMITS

A study team was established comprising of representatives from the Corps, U.S. Fish and Wildlife Service and Massachusetts Division of Fisheries and Wildlife. Based on a site visit by the team members, the study area was determined to include the aquatic habitat within the impact areas about 2.3 miles upstream of the Hodges Village Dam and the downstream to about 2.7 miles to the French River's confluence with Lowes Brook. It was agreed by the team members that downstream of that point the effects of low flow augmentation to 10 cfs would not be measurable by the HEP study. The team concurred that below the confluence of Lowes Brook, the combined inflows of other tributary streams, wetland drainages and land runoff would exert a greater influence on the fish community of that reach of the French River than the augmented flows acting alone.

B. SPECIES SELECTION:

On 2 and 15 August 1983, members of the HEP team sampled the fish population of the French River upstream and downstream of the dam with the use of a boat electroshocker. The results of those collections in terms of species, numbers and biomass are exhibited in Table 1. The upstream community was dominated by white sucker, golden shiner, pumpkinseed and largemouth bass whereas the downstream populations were dominated by largemouth bass, pumpkinseed, chain pickerel, and creek chubsucker.

Because of monetary and time constraints, evaluation species were limited to those for which existing models were available for calculation of habitat quality or the Habitat Suitability Index (HSI). As a result, the analysis did not address impacts to prey species such as golden shiner or wetland spawners such as yellow perch or chain pickerel. No formal guild analysis was performed.

Four species were chosen: largemouth bass, bluegill, white sucker and bullhead. Other species that were considered included fallfish, chain pickerel, golden shiner and yellow perch. The lack of or nonapplicability of existing models were the main reasons for not including these species.

C. SPECIES MODELS

The HEP analysis requires the determination of habitat quality for a given evaluation species in the form of a Habitat Suitability Index (ESM 102 FWS, 1980). Species models have been developed by the FWS to calculate the indices.

The models used for the study included three published models and one in draft form including largemouth bass (Stuber et al., 1982a), bluegill (Stuber et al.,1982b), white sucker (Anonymous, 1981), and black bullhead (Stuber, 1982). Because no models were available for the brown or yellow bullhead which occur in the French River system, the black bullhead model was used as a surrogate; brown and black bullheads are closely related and have been reported to hybridize (Trautman, 1957).

D. APPLICATION AND/OR MODIFICATION OF THE SPECIES MODELS

The above selected species models focus on habitat variables (V) which may affect population levels of a species in a given habitat. These variables are used to determine the HSI in terms of the food, cover, water quality and reproduction life requisites that the habitat can provide. The HEP team decided to use the mechanistic models presented in each of the above cited publications with the exception of white sucker, where a lacustrine mechanistic model has not yet been developed. A modified "word" model also presented in the publication was used in its place. The models were all used as presented in each publication with the following modifications.

1. Largemouth bass.
   V2 - Percent lacustrine area $\leq$ 6 m depth:

The existing Suitability Index graphs for northern latitudes assumes the suitability would decrease when the depths of 6 m exceeds 60% of the area. This is true for a confined lacustrine system which could affect winter survival of largemouth bass. However, in the present situation ice formation in the dammed riverine system would not be limiting to winter survival. Thus, the suitability index was assumed not to decrease in the proposed situation.

V9 - Average weekly mean temperature within pools in littoral area during spawning and incubation (embryo):

Such temperatures in suitable spawning areas during the spawning period were not available. It was assumed that such areas or water temperatures in these areas were not limiting nor would the project affect the suitability because of the extent of backwater and slow water areas and the apparent healthy bass population. Thus the variable was not included in the calculation of the reproduction component.

V10 - Average water temperature with pools, backwaters or littoral areas during the growing season (fry):

This parameter was also dropped from consideration because it was determined that the variable was not limiting for the same reasons described in V9.

V12, V13, and V14 Salinity:

These variables were not considered because of the completely fresh water nature of the French River System.

V20 and V21 - Average current velocity during spawning and summer for embryo and fry:

Measurements of velocities in suitable spawning and nursery areas were not available; it was assumed that this parameter would not be limiting and would not be affected by the low flow augmentation downstream.

2. Bluegill.

V4 - Percent littoral area during summer stratification:

The same reasoning used for V2 in largemouth bass applies to modification of this suitability index graph. Since winter survival would not depend on the area of deeper water, the parameter was assumed to have a suitability index 1.0 at 100% littoral area.

V11 - Average of mean weekly water temperature within pools or littoral areas during spawning:

See discussion for V9, largemouth bass.

V15 and V16 - Average current velocity in spawning and nursery areas:

See discussion of V20 - V21, largemouth bass.

3. White Sucker:

Model 2 was utilized to determine the habitat suitability index of the proposed lake. The graph for V1 (% Cover) was used to determine a suitability index for the criteria: "greater than 30% of littoral area with aquatic vegetation." Other variables were given a 1.0 value.

4. Bullhead.

V7 and V8 Salinity:

See discussion of V12 - V14, largemouth bass.

V10 - Average water temperature with pools, backwaters in littoral areas during spawning and embryonic development (embryo):

See discussion of V9, largemouth bass.

III. BASELINE DATA.

After a survey of the study area by the team, seven stations (four upstream of Hodges Village Dam and three downstream) were chosen for sampling. Each station consisted of a 400 ft. reach of the river with 4 transects spaced about 100 ft. apart. The variables listed in each model were determined for each transect.

The baseline data for the models were determined by the following methods.

1.	% Cover:	ocular estimatation using a measured transect
2.	Substrate:	ocular estimatation
3.	% Pools:	ocular estimatation
4.	Maximum summer water temperature:	field measurements and recorded data
5.	Average summer water temperature:	recorded data
6.	Turbidity:	recorded data
7.	Water Fluctuation-upstream:	recorded data, rule curve (Figure I-1)
8.	Water fluctuation-downstream:	recorded data; ocular estimation
9.	pH:	recorded data
10.	Dissolved Oxygen:	recorded data and field measurements
11.	Current vélocities - instream:	Calculated with Manning's formula

(Q (flow) = V (velocity) x A (Area)) and field measurements.

The collected and computed baseline data for each species are summarized in Tables 2 - 9. The habitat suitability indices for each life requisite component considered by the model is shown in the lower portion of each Table. The Habitat Suitability Index (HSI) for each station was computed according to the appropriate model and upstream and downstream means were calculated.

IV FUTURES WITHOUT PROJECT:

Separate HEP analyses were carried out for upstream and downstream impact areas.

The baseline data were used to calculate baseline Habitat Suitability Indices which were, in turn, used as a basis to project the habitat changes over the project life - 100 years.

Two target years were chosen by the HEP team in accordance with ESM 102: Target Year "0" and Target Year "100". The assumption was made that the parameters exhibited in Tables 2 - 9 would not significantly change beyond the ranges described in each model over the course of the project life. The baseline habitat units and Average Annual Habitat Units for both Target Years are calculated in Table 10. Similarly, the downstream calculations are shown in Table 11 for each species. Because there is no change in the HSI or area the AAHU's are equal to the HU at Target Year "0".

V. FUTURE WITH PROJECT WITHOUT WILDLIFE MITIGATION

The future with Low Flow Augmentation was projected by establishing four Target Years for the purpose of the study: Target Year "0", "1", "5" and "100". Target Year "0" represents existing baseline conditions. Target Year "1" represents conditions after a one year construction period. (Actually, the proposed construction is expected to take 1 year and 2 months time to complete; one year was assumed for the purpose of the HEP study). Target Year "5" was chosen as the time it takes for the proposed lake upstream of the dam to stabilize as fish habitat. Target Year "100" is the end of the project life. The following assumptions were made about the future conditions.

1. Total dissolved solids, pH, and dissolved $^{0}2$, would not significantly change throughout project life in lacustrine or downstream habitats. It was assumed that the appropriate erosion control measures would be used during construction and the resultant changes in downstream water quality would not significantly vary outside of the range of the model variables.

2. % pools, substrate were also assumed not to significantly change throughout the project life.

3. Habitat Suitability Index at Target Year "1" (after completion of construction): It was assumed that the newly constructed lake at Target Year "1" would have a HSI of 0 because fish would probably not utilize the habitat until the construction period was over. The fish populations were assumed to gradually increase from target year "1" to "5" when the population would probably stabilize. This increase would be reflected by the linear increase in HSI from year "1" to "5".

4.. % Cover for lacustrine habitat would be 0 for Target Year "5". It was assumed by Target Year "100" that 25% submergent vegetation would have developed in the littoral zone of the lake and that 5% debris would have accumulated.

5. % cover in downstream riverine habitat would not significantly change over the project life.

6. Water fluctuation upstream: The fluctuation volumes calculated from past storms was projected on the surface of the augmentation pool.

7. Water fluctuation downstream: It was assumed that the fluctuations would not significantly change since the flood control gates would remain manually operated.

8. Water velocities - downstream: Future velocity measurements for the downstream site were projected using Manning's formula based on a augmented flow of 10 cfs at the Hodges Village Dam outlet works.

9. Water Temperatures: The upstream and downstream temperatures were calculated data from a computer simulation study based on three study years. The inflow temperature was used to project lacustrine water temperature and the outflow for the downstream sites. It was assumed that water passing through Auguttenback Pond, downstream of the dam, would increase the outflow temperature about $0.5^{o}F$.

10. Average area of Lacustrine Habitat: The area of the new lake was calculated by weighing the acreage of the permanent pool and the augmentation pool by the duration of the occurance of each pool in the space of one year. The stripped permanent pool (103 acres) would occur 2/3 of a year and the stripped augmentation pool (155 acres) for the remainder. Hence, (0.67 x 103) + (0.33 x 155) = 120 acres.

Tables 12 - 15 exhibit the future model variables of the proposed lake upstream of the dam and Tables 16 - 19 for future variables for each station downstream of dam based on the above assumptions. The lower portion of the Table indicates changes in life requisite components and Habitat Suitability Indices. The mean HSI for the upstream and downstream section were then used to determine the Habitat Unit and Average Annual Habitat Units for each Target Year for each species. These are illustrated in Tables 20 and 21 for the upstream and downstream analyses.

Table 22 compared the change in AAHU's compared with the future without the project. It indicated that a total of 341 AAHU's were gained from development of the proposed lake without wildlife mitigation. This minus the loss of 37 AAHU's of the upstream riverine habitat yields a net gain of 304 AAHU's. No change is expected to occur in downstream habitat units.

VI. FUTURE WITH PROJECT WITH WILDLIFE MITIGATION

The basic difference between futures with and without wildlife mitigation is the acreage of the proposed lake upstream of the dam. The same criteria used to calculate the weighted pool area as above was applied. The stripped permanent pool (113 acres) would occur 2/3 of a year and the augmentation (155 acres) pool for the remainder. Hence (0.67 x 113) + (0.33 x 155) = 127 acres.

The Habitat Units and AAHU's for this acreage are exhibited in Table 23. The change in AAHU's is shown in Table 24. Comparison with AAHU's without the project indicates a net increase of 324 AAHU's. Thus, the implementation of the proposed wildlife mitigation measures would increase the AAHU's gained with project implementation by 20.

TABLE 1
FISH SPECIES* OF THE FRENCH RIVER

Common Name	Scientific Name	Upper Hodges Village Reservoir		Lower Hodges Village Reservoir		Downstream of Hodges Village Dam	
		No.	lbs.	No.	lbs.	No.	lbs.
White sucker	Catostomus commersoni	62	55.2	18	18.4	2	2.0
Creek chubsucker	Erimyzon oblongus	-	-	-	-	12	1.3
Golden shiner	Notemigonus crysoleucas	12	1.8	27	3.6	5	0.1
Fallfish	Semotilus corporalis	5	1.8	-	-	-	-
Largemouth bass	Micropterus salmoides	11	3.1	19	10.8	19	7.4
Pumkinseed	Lepomis gibbosus	12	0.8	48	5.8	16	0.4
Red-breasted sunfish	Lepomis auritus	-	-	-	-	8	1.2
Bluegill	Lepomis macrochirus	-	-	4	0.8	4	0.7
Brown Bullhead	Ictalurus nebulosus	1	0.08	6	0.6	1	0.2
Yellow bullhead	Ictalurus natalis	1	-	-	-	2	0.8
Chain pickerel	Esox niger	5	0.4	12	4.4	17	5.2
Yellow perch	Perca flavescens	-	-	-	-	3	0.8
American eel	Anguilla rostrata	-	-	-	-	2	3.8

*Species collected by electroshocking on 2, 15 August 1983

TABLE 2
LARGEMOUTH BASS BASELINE DATA FOR SITES A, B, C AND D
UPSTREAM OF HODGES VILLAGE DAM

Site	A		B		C		D	
Model Variable (Condition)	Value	SI	Value	SI	Value	SI	Value	SI
V1 % Pool/backwater (summer)	100	1.00	100	1.00	100	1.00	100	1.00
V3 % bottom cover (adult,juv)	20.5	0.60	22.8	0.64	24.5	0.68	24.3	0.68
V4 % bottom cover (fry)	20.5	0.50	22.8	0.56	24.5	0.56	24.3	0.56
V6 Min. Dissolved O_2(mg/l,summer)	5-8	0.80	5-8	0.80	5-8	0.80	5-8	0.80
V7 pH	6.5-8.5	1.00	6.5-8.5	1.00	6.5-8.5	1.00	6.5-8.5	1.00
V8 Ave.Water Temp. (^{o}C) (adult/juv.)	18.5	0.40	18.5	0.40	18.5	0.40	18.5	0.40
V11 Turbidity (ppm)	$\leq$ 25	1.00	$\leq$ 25	1.00	$\leq$ 25	1.00	$\leq$ 25	1.00
V15 Substrate (pools)	*	0.70	*	0.30	*	0.90	*	0.80
V16 Ave. Water Fluctuation (m) (adult, juv)	0.3	0.99	0.3	0.99	0.7	0.97	1.7	0.90
V17 Max. Water Fluctuation (m) (embryo)	0.3	0.94	0.3	0.97	1.5	0.95	+2.5	0.75
V18 Ave. Water Fluctuation (fry)	0.3	1.00	0.3	1.00	0.7	1.00	-1.7	0.90
V19 Ave Velocity (cm/sec) 0.6 depth (summer)	2.9	1.00	1.5	1.00	1.80	1.00	1.4	1.00
Life Requisite Components								
Food		0.74		0.77		0.78		0.79
Cover		0.82		0.84		0.85		0.82
Water Quality		0.73		0.73		0.73		0.73
Reproduction		0.87		0.65		0.95		0.84
Other (velocity)		1.00		1.00		0.90		1.00
Habitat Suitability Index		0.83		0.79		0.84		0.83

Mean HSI Upstream Sites = 0.83

*Resultant Suitability Index (SI) computed by weighted mean of four transects

TABLE 3
BLUEGILL
BASELINE DATA FOR SITES A, B, C AND D
WITHOUT PROJECT UPSTREAM OF HODGES VILLAGE DAM

	A		B		C		D	
Model Variable (Condition)	Value	SI	Value	SI	Value	SI	Value	SI
V1 % Pool	100	1.00	100	1.00	100	1.00	100	1.00
V2 % Cover (debris)	17.3	0.90	21.5	1.00	16.5	0.70	8.25	0.50
V3 % Cover (vegetation)	6.75	0.40	2.5	0.15	14.5	0.95	16.0	1.00
V6 Max Ave. Turbidity (ppm)	<25	1.00	<25	1.00	<25	1.00	<25	1.00
V7 pH	6.5-8.5	1.00	6.5-8.5	1.00	6.5-8.5	1.00	6.5-8.5	1.00
V8 Min Diss O_2 (mg/l (summer)	seldom<5	1.00	seldom<5	1.00	seldon<5	1.00	seldom<5	1.00
V10 Max water temp. (^oC)(adult)	26.7	1.00	26.7	1.00	26.7	1.00	28.5	0.45
V11 Ave. water Temp. (^oC)(embryo)	22	1.00	22	1.00	22	1.00	22	1.00
V12 Max water temp (^oC) (early summer: fry)	25.6	1.00	25.6	1.00	25.6	1.00	25.6	1.00
V13 Max. Water temp (^oC) (juv)	26.7	0.80	26.7	0.80	26.7	0.80	28.5	0.90
V14 Ave water velocity(cm/sec) (adult)	6.6	1.00	3	1.00	4	1.00	2.1	1.0

TABLE 3 (Continued)
BLUEGILL
BASELINE DATA FOR SITES A, B, C AND D
WITHOUT PROJECT UPSTREAM OF HODGES VILLAGE DAM

Model Variable (Condition)	A Value	A SI	B Value	B SI	C Value	C SI	D Value	D SI
V17 Ave. Water velocity(cm/sec) (juv)	6.6	0.80	3	1.00	4	1.00	2.1	1.0
V18 Stream gradient (m/km)	1.3	0.70	1.3	0.70	1.3	0.70	1.3	0.70
V20 Substrate (embryo)	fines & gravel	1.00	fines/gravel	1.00	fines/gravel	1.00	fines/gravel	1.0
Life Requisite Components								
Food		0.71		0.53		0.87		0.79
Cover		0.65		0.58		0.83		0.30
Water Quality		0.98		0.98		0.98		0.91
Reproduction		1.00		1.00		1.00		1.00
Other		0.80		0.85		0.85		0.85
Habitat Suitability Index		0.84		0.79		0.92		0.74
Mean HSI Upstream Sites			= 0.82					

TABLE 4
WHITE SUCKER
BASELINE DATA FOR SITES A, B, C AND D
WITHOUT PROJECT UPSTREAM OF HODGES VILLAGE DAM

Model Variable (Condition)	A Value	A SI	B Value	B SI	C Value	C SI	D Value	D SI
V1 % Cover	20.5	0.70	22.8	0.75	24.5	0.82	24.3	0.82
V2 Max. Ave. Turbidity (JTU)	2.2	1.00	2.2	1.00	2.2	1.00	2.2	1.00
V3 pH Range	6-9	0.80	6-9	0.80	6-9	0.80	6-9	0.80
V4 Stream Gradient (m/km)	1.3	0.90	1.3	0.90	1.3	0.90	1.3	0.90
V5 % Pool (July)	100	0.50	100	0.50	100	0.50	100	0.50
V6 % Pool (April-June)	100	0.50	100	0.50	100	0.50	100	0.50
V8 Diss. O_2 (mg/l)	>5	1.00	>5	1.00	>5	1.00	>5	1.00
V9 Ave.Water temp.(°C;Adults,Juv.)	21	1.00	21	1.00	21	1.00	21	1.00
V10 Ave. Water Temp. (°C; Fry)	21	1.00	21	1.00	21	1.00	21	1.00
V11 Ave. Water Temp. (°C; Embryo)	15	1.00	15	1.00	15	1.00	15	1.00
Life Requisite Components								
Food		0.60		0.63		0.66		0.66
Cover		0.77		0.80		0.85		0.85
Water Quality		0.96		0.96		0.96		0.96
Reproduction		0.71		0.71		0.71		0.71
Habitat Suitability Index		0.79		0.80		0.82		0.82
Mean HSI Upstream Sites					= 0.81			

TABLE 5
BULLHEAD
BASELINE DATA FOR SITES A, B, C AND D
WITHOUT PROJECT UPSTREAM OF HODGES VILLAGE DAM

	A		B		C		D	
Model Variables (Condition	Value	SI	Value	SI	Value	SI	Value	SI
V1 % Pools	100	0.70	100	0.70	100	0.70	100	0.70
V2 % Cover	20.5	0.83	22.8	0.90	24.5	1.0	24.3	1.00
V3 Avé. Water Velocity (cm/sec)	2.9	1.0	1.5	1.0	1.8	1.0	1.4	1.00
V4 Max. Water Temp (^{o}C)	26.7	1.0	26.7	1.0	26.7	1.0	28.5	1.00
V5 Diss. O_2 (mg/1)	seldom <6	1.0	seldom <6	1.0	seldom <6	1.0	seldom<6	1.00
V6 pH	6.5-8.5	1.00	6.5-8.5	1.00	6.5-8.5	1.00	6.5-8.5	1.00
V7 Turbidity (ppm)	<25	0.70	<25	0.70	<25	0.70	<25	0.70
V11 Substrate (pools)	*	0.7	*	0.83	*	0.75	*	1.00
V12 % Cover (embryo)	30	1.0	31	1.0	31	1.0	60	1.00
Life Requisite Components								
Food		0.76		0.79		0.84		0.84
Cover		0.83		0.93		0.89		0.89
Water Quality		0.95		0.95		0.95		0.95
Reproduction		0.79		0.83		0.81		0.89
Habitat Suitability Index		0.83		0.87		0.87		0.89
Mean HSI Upstream Sites = 0.87								

* Resultant SI computed from weighted mean of four transects.

TABLE 6
LARGEMOUTH BASS
BASELINE DATA WITHOUT PROJECT FOR SITES E, F AND G
DOWNSTREAM OF HODGES VILLAGE DAM

	E		F		G	
Model Variable (Condition)	Value	SI	Value	SI	Value	SI
V1 % Pool/backwater (summer)	100	1.00	100	1.00	100	1.00
V3 % Bottom cover (adult, juv)	15	0.50	37.5	1.00	72.5	0.85
V4 % Bottomcover (fry)	15	0.35	37.5	0.95	72.5	1.00
V6 % Min. Diss. O_2 (mg/l)(summer)	5-8	0.80	5-8	0.80	5-8	0.80
V7 pH	6.5-8.5	1.00	6.5-8.5	1.00	6.5-8.5	1.00
V8 Ave. Water Temp (^{o}C; adult, juv.)	18.9	0.47	18.9	0.47	18.9	0.47
V11 Turbidity (ppm)	<25	1.00	<25	1.00	<25	1.00
V15 Substrate (pool)	gravel	1.00	*	0.83	*	0.75
V16 Ave. Water fluctuation(m) (adult, juv)	0.3	0.99	0.3	0.99	0.3	0.99
V17 Max. Water Fluctuation (m) (embryo)	0.3	0.94	0.3	0.94	0.3	0.94
V17 Ave. Water Fluctuation (m)	0.3	1.00	0.3	1.00	0.3	1.00
V19 Ave. Water Velocity(cm/sec)(summer)	4.0	1.00	2.8	1.00	7.0	0.94

TABLE 6 (Continued)
LARGEMOUTH BASS
BASELINE DATA WITHOUT PROJECT FOR SITES E, F AND G
DOWNSTREAM OF HODGES VILLAGE DAM

	E		F		G	
Model Variable (Condition)	Value	SI	Value	SI	Value	SI
Life Requisite Components						
Food		0.66		0.99		0.96
Cover		0.75		0.99		0.97
Water Quality		0.76		0.76		0.76
Reproduction		0.98		0.92		0.89
Other (velocity)		1.00		1.00		0.97
Habitat Suitability Index		0.82		0.93		0.91
Mean HSI Downstream Sites			= 0.89			

* Resultant SI computed by weighted mean of four transects.

TABLE 7
BLUEGILL
BASELINE DATA FOR SITES E, F & G
WITHOUT PROJECT DOWNSTREAM OF HODGES VILLAGE DAM

	E		F		G	
Model Variable (Condition)	Value	SI	Value	SI	Value	SI
V1 % Pool	100	1.00	100	1.00	100	1.00
V2 % Cover (debris)	1.75	0.25	23.5	1.00	10	0.17
V3 % Cover (vegetation)	15	1.00	19	1.00	65	0.50
V6 Max ave. Turbidity (ppm)	<25	1.00	<25	1.00	<25	1.00
V7 pH	6.5-8.5	1.00	6.5-8.5	1.00	6.5-8.5	1.00
V8 Min Diss. O_2 (mg/l)(summer)	seldom <5	1.00	seldom <5	1.00	seldom <5	1.00
V10 Max. Water Temp (^oC) (adult)	26.4	1.00	26.4	1.00	26.4	1.00
V11 Ave. Water Temp (^oC)(embryo)	22	1.00	22	1.00	22	1.00
V12 Max. Water Temp (^oC) (early summer:fry)	25.8	1.00	25.8	1.00	25.8	1.00
V13 Max. Water Temp (^oC) (Juv)	26.4	0.79	26.4	1.00	26.4	0.79
V14 Ave. Water Velocity (cm/sec) (adult)	9.4	1.00	6.1	1.00	9.6	1.00

TABLE 7 (Continued)
BLUEGILL
BASELINE DATA FOR SITES E, F & G
WITHOUT PROJECT DOWNSTREAM OF HODGES VILLAGE DAM

	E		F		G	
Model Variable (Condition)	Value	SI	Value	SI	Value	SI
V17 Ave. Water Velocity (cm/sec) (juv)	9.4	1.00	6.1	1.00	9.6	1.00
V18 Stream Gradient (m/km)	0.42	1.00	<0.5	1.00	<0.5	1.00
V20 Substrate (embryo)	fines/gravel	1.00	fines/gravel	1.00	fines/gravel	1.00
Life Requisite Components						
Food		0.63		1.00		0.44
Cover		0.63		1.00		0.34
Water Quality		0.97		0.97		0.97
Reproduction		1.00		1.00		1.00
Other		1.00		1.00		1.00
Habitat Suitability Index		0.85		0.99		0.72
Mean HSI Downstream Sites			= 0.85			

TABLE 8
WHITE SUCKER
BASELINE DATA FOR SITES E, F AND G
WITHOUT PROJECT DOWNSTREAM OF HODGES VILLAGE DAM

	E		F		G	
Model Variable (Condition)	Value	SI	Value	SI	Value	SI
V1 % Cover	15	0.60	37.5	0.95	72.5	0.90
V2 Max. Ave. Turbidity (JTU)	2.2	1.00	2.2	1.00	2.2	1.00
V3 pH range	6-9	0.80	6-9	0.80	6-9	0.80
V4 Stream gradient (m/km)	0.42	0.85	<0.5	0.86	<.5	0.85
V5 % Pool (July)	100	0.50	100	0.50	100	0.50
V6 % Pool (April-June)	100	0.50	100	0.50	100	0.50
V8 % Diss. O_2 Range	>5	1.00	>5	1.00	>5	1.00
V9 Ave. Water Temp (^{o}C;Adult, Juv.)	21.3	1.00	21.3	1.00	21.3	1.00
V10 Ave. Water Temp (^{o}C; Fry)	21.3	1.00	21.3	1.00	21.3	1.00
V11 Ave. Water Temp (^{o}C; Embryo)	15.3	1.00	15.3	1.00	15.3	1.00
Life Requisite Components						
Food		0.55		0.73		0.70
Cover		0.68		0.92		0.89
Water Quality		0.96		0.96		0.86
Reproduction		0.71		0.85		0.71
Habitat Suitability Index		0.75		0.85		0.84
Mean HSI Downstream Sites			= 0.81			

TABLE 9
BULLHEAD
BASELINE DATA FOR SITES E, F AND G
WITH PROJECT DOWNSTREAM OF HODGES VILLAGE DAM

	E		F		G	
Medel Variables (Condition)	Value	SI	Value	SI	Value	SI
V1 % Pools	100	0.70	100	0.70	100	0.70
V2 % Cover	15	0.60	37.5	1.00	72.5	1.00
V3 Ave. Water Velocity (cm/sec)	6.25	0.94	3.65	1.00	9.3	0.87
V4 Max. Water Temp (^{o}C)	27.2	1.00	27.2	1.00	27.2	1.00
V5 Diss O_2 (mg/l)	seldom<6	1.00	seldom<6	1.00	seldom<6	1.00
V6 pH	6.5-8.5	1.00	6.5-8.5	1.00	6.5-8.5	1.00
V7 Turbidity (ppm)	<25	0.70	<25	0.70	<25	0.70
V11 Substrate (pools)	*	0.50	*	0.88	*	0.88
V12 % Cover (embryo)	21.25	1.00	43	1.00	76.3	1.00
Life Requisite Components						
Food		0.65		0.84		0.84
Cover		0.73		0.89		0.87
Water Quality		0.95		0.95		0.95
Reproduction		0.82		0.82		0.85
Habitat Suitability Index		0.78		0.87		0.88
Mean HSI Downstream Sites		= 0.84				

* Resultant SI Computed from a weighted mean of four transects

TABLE 10
HABITAT UNITS (HU) AND AVERAGE ANNUAL HABITAT UNITS
(AAHU) FOR BASELINE AND TARGET YEARS FOR THE UPSTREAM STUDY AREA

Upstream

Target Year	Area (Acres)	HSI	HU	Years	HU-Years	AAHU
Largemouth Bass						
Baseline	11	0.83	9.13	--	0	
100	11	0.83	9.13	0-100	913	9.13
Bluegill						
Baseline	11	0.82	9.02	--	0	
100	11	0.82	9.02	0-100	902	9.02
White Sucker						
Baseline	11	0.81	8.91	--	0	
100	11	0.81	8.91	0-100	891	8.91
Bullhead						
Baseline	11	0.87	9.57	--	0	
100	11	0.87	9.59	0-100	957	9.57

TABLE 11
HU AND AAHU WITH PROJECT WITHOUT WILDLIFE MITIGATION
FOR BASELINE AND TARGET YEARS FOR THE DOWNSTREAM STUDY AREA

Downstream

Target Year	Area (Acres)	HSI	HU	Year	HU-Year	AAHU
	Largemouth bass					
Baseline	17	0.89	15.13	--	0	
100	17	0.89	15.13	0-100	1513	15.13
	Bluegill					
Baseline	17	0.85	14.45	--	0	
100	17	0.85	14.45	0-100	1445	14.45
	White Sucker					
Baseline	17	0.81	13.77	--	0	
100	17	0.81	13.77	0-100	1377	13.77
	Bullhead					
Baseline	17	0.84	14.28	--	0	
100	17	0.84	14.28	0-100	1428	14.28

TABLE 12
LARGEMOUTH BASS
DATA FOR TARGET YEARS 5 AND 100 WITH PROJECT FOR
LACUSTRINE HABITAT UPSTREAM OF HODGES VILLAGE DAM

Target Year	5		100	
Model Variable (Condition)	Value	SI	Value	SI
V2 % Area ≤ 6 m depth	100	1.00	100	1.00
V3 % Bottom Cover (adult, juv)	0.01	0.02	30	0.80
V4 % Bottom Cover (fry)	0.01	0.01	30	0.75
V5 Ave. Total Dissolved Solids(ppm)	50	0.50	50	0.50
V6 Min. Diss. O_2 (summer)	5-8	0.80	5-8	0.80
V7 pH	6.5-8.5	1.00	6.5-8.5	1.00
V8 Ave. Water Temp. (adult, juv.)	20	0.58	20	0.58
V11 Turbidity (ppm)	<25	1.00	<25	1.00
V15 Substrate (littoral area)	gravel	1.00	gravel	1.00
V16 Ave. Water Fluctuation (m) (adult, juv)	1.3	0.90	1.3	0.90
V17 Max. Water Fluctuation (m) (embryo)	1.3	0.85	1.3	0.85
V18 Ave. Water Fluctuation (m) (fry)	1.3	0.92	1.3	0.92
Life Requisite Components				
Food		0.50		0.50
Cover		0.65		0.89
Water Quality		0.79		0.79
Reproduction		0.95		0.95
HSI		0.70		0.76

TABLE 13
BLUEGILL
DATA FOR TARGET YEARS 5 AND 100 WITH PROJECT FOR
LACUSTRINE HABITAT UPSTREAM OF HODGES VILLAGE DAM

Target Year	5		100	
Model Variable (Condition	Value	SI	Value	SI
V2 % Cover (debris)	0	0.20	5	0.35
V3 % Cover (vegetation)	0	0.20	25	1.00
V4 % Littoral area	100	1.00	100	1.00
V5 Ave. Total Dissolved Solids(ppm)	50	0.50	50	0.50
V6 Max. Ave. Turbidity (ppm)	<25	1.00	<25	1.00
V7 pH	6.5-8.5	1.00	6.5-8.5	1.00
V8 Min. Diss. O_2(mg/l)(summer)	seldom <5	1.00	seldom <5	1.00
V10 Max. Water Temp. (°C)(adult)	28.5	0.45	28.5	0.45
V11 Ave. Water Temp. (°C) (embryo)	22	1.00	22	1.00
V12 Max. Water Temp. (°C) (Fry)	26	1.00	26	1.00
V13 Max. Water Temp. (°C)(Juv.)	28.5	0.90	28.5	0.90
V19 Reservoir Drawdown (embryo)	<1m	1.00	<1m	1.00
V20 Substrate (embryo)	fines/gravel	1.00	fines/gravel	1.00
Life Requisite Components				
Food		0.38		0.77
Cover		0.44		0.68
Water Quality		0.91		0.91
Reproduction		1.00		1.00
Habitat Suitability Index		0.67		0.85

TABLE 14
WHITE SUCKER
DATA FOR TARGET YEARS 5 AND 100 WITH PROJECT FOR
LACUSTRINE HABITAT UPSTREAM OF HODGES VILLAGE

Target Year	5	10
Model Variable (Model 2)		
% Cover	0	0.9*
Max ave. Turbidity	1	1
Substrate	1	1
Habitat Suitability Index	0.67	0.97

* Computed from response curve for V1 - % Cover.

TABLE 15
BULLHEAD
DATA FOR TARGET YEARS 5 AND 100 WITH PROJECT FOR
LACUSTRINE HABITAT UPSTREAM OF HODGES VILLAGE DAM

Target Year	5		100	
Model Variable (Condition)	Value	SI	Value	SI
V2 % Cover	0	0.001	30.%	1.00
V4 Max summer Water Temp (°C)	28.5	1.00	28.5	1.00
V5 Diss. O_2 (mg/l)	seldom <6	1.00	seldom <6	1.00
V6 pH	6.5-8.5	1.00	6.5-8.5	1.00
V9 Turbidity (ppm)	<25	0.70	<25	0.70
V11 Substrate	fines & gravel noticeable	0.50	fines & gravel noticeable	0.50
V12 % Cover (embryo)	0	0.20	30	1.00
V13 Ave. Total dissolved solids (ppm)	50	0.50	50	0.50
V14 % Littoral area (summer)	100	1.00	100	1.00
V15 Lake area (hectares)	<200	1.00	<200	1.00
V16 Reservoir Drawdown (m) (embryo)	<0.1	1.00	<0.1	1.00
Life Requisite Component				
Food		0.50		0.50
Cover		0.10		1.00
Water Quality		0.95		0.95
Reproduction		0.56		0.34
Habitat Suitability Index		0.40		0.80

TABLE 16
LARGEMOUTH BASS
DATA FOR TARGET YEARS 5,100 WITH PROJECT FOR SITES E, F AND G
DOWNSTREAM OF HODGES VILLAGE DAM

	E		F		G	
Model Variable (Condition)	Value	SI	Value	SI	Value	SI
V1 % Pool/backwater (summer)	100	1.00	100	1.00	100	1.00
V3 % Bottom Cover (adult, juv)	15	0.50	37.5	0.95	72.5	1.00
V4 % Bottom Cover (fry)*	15	0.35	37.5	0.95	72.5	1.00
V6 Min. Diss. O_2 (mg/l)(summer)	5-8	0.80	5-8	0.80	5-8	0.80
V7 pH	6.5-8.5	1.00	6.5-8.5	1.00	6.5-8.5	1.00
V8 Ave. Water Temp ^{o}C (adult, juv)	19.5	0.62	19.5	0.62	19.5	0.62
V11 Turbidity (ppm)	<25	1.00	<25	1.00	<25	1.00
V15 Substrate (pool)	gravel	1.00	*	0.83	*	0.75
V16 Ave. Water Fluctuation (m) (adult, juv)	0.3	0.99	0.3	0.99	0.3	0.99
V17 Max. Water Fluctuation (m)(embryo)	0.3	0.94	0.3	0.94	0.3	0.94
V18 Ave. Water Fluctuation (m)(fry)	0.3	1.00	0.3	1.00	0.3	1.00
V19 Ave. Water Velocity (cm/sec) (summer)	6.25	0.99	3.65	1.00	9.3	0.75
Life Requisite Components						
Food		0.65		0.99		0.96
Cover		0.75		0.99		0.97
Water Quality		0.81		0.81		0.81
Reproduction		0.98		0.98		0.98
Other (velocity)		0.99		1.00		0.75
Habitat Suitability Index		0.83		0.95		0.89
Mean HSI Downstream Sites			= 0.89			

* Resultant SI computed by weight mean of four transects

TABLE 17
BLUEGILL
DATA FOR TARGET YEARS 5,100 FOR SITES E, F, AND G
WITH PROJECT DOWNSTREAM OF HODGES VILLAGE DAM

	E		F		G	
Model Variable (Condition)	Value	SI	Value	SI	Value	SI
V1 % Pool	100	1.00	100	1.00	100	1.00
V2 % Cover (debris	1.75	0.25	23.5	1.00	10	0.17
V3 % Cover (vegetation)	15	1.00	19	1.00	65	0.50
V6 Max ave. Turbidity (ppm)	<25	1.00	<25	1.00	<25	1.00
V7 pH	6.5-8.5	1.00	6.5-8.5	1.00	6.5-8.5	1.00
V8 Min Diss O_2 (mg/l)(summer)	seldom <5	1.00	seldom <5	1.00	seldom <5	1.00
V10 Max. Water Temp (°C)(adult)	27.2	1.00	27.2	1.00	27.2	1.00
V11 Ave. Water Temp (°C)(embryo)	22	1.00	22	1.00	22	1.00
V12 Max. Water Temo(°C)(early sum:fry)	26.1	1.00	26.1	1.00	26.1	1.00
V13 Max. Water Temp (°C)(juv)	27.2	0.82	27.2	1.00	27.2	0.79
V14 Ave. Water Velocity (cm/sec)(adult)	9.4	1.00	6.1	1.00	9.6	1.00
V17 Ave. Water Velocity (cm (sm) (juv.)	9.4	1.00	6.1	1.00	9.6	1.00
V18 Stream Gradient (m/km)	0.42	1.00	<0.5	1.00	<0.5	1.00
V20 Substrate (embryo)	fines/gravel	1.00	fines/gravel	1.00	fines/gravel	1.00
Life Requisite Components						
Food		0.63		1.00		0.44
Cover		0.63		1.00		0.34
Water Quality		0.98		0.98		0.98
Reproduction		1.00		1.00		1.00
Other		1.00		1.00		1.00
Habitat Suitability Index		0.85		0.99		0.72
Mean HSI Downstream Sites		= 0.85				

TABLE 18
WHITE SUCKER
DATA FOR TARGET YEARS 5 AND 100 FOR SITES E, F AND G
WITH PROJECT DOWNSTREAM OF HODGES VILLAGE DAM

	E		F		G	
Model Variable (Condition)	Value	SI	Value	SI	Value	SI
V1 % Cover	15	0.60	37.5	0.95	72.5	0.90
V2 Max. Ave Turbidity (JTU)	2.2	1.00	2.2	1.00	2.2	1.00
V3 pH Range	6-9	0.80	6-9	0.80	6-9	0.80
V4 Stream Gradient (m/km)	0.42	0.85	<0.5	0.86	<0.5	0.86
V5 % Pool (July	100	0.50	100	0.50	100	0.50
V6 % Pool (April - June)	100	0.50	100	0.50	100	0.50
V8 Diss O_2 range	>5	1.00	>5	1.00	>5	1.00
V9 Ave. Water Temp(°C;Adult, Juv.)	22	1.00	22	1.00	22	1.00
V10 Ave. Water Temp (°C, Fry)	22	1.00	22	1.00	22	1.00
V11 Ave. Water Temp (°C; Embryo)	15.3	1.00	15.3	1.00	15.3	1.00
Life Requisite Components						
Food		0.55		0.73		0.70
Cover		0.68		0.92		0.89
Water Quality		0.96		0.96		0.96
Reproduction		0.71		0.85		0.71
Habitat Suitability Index		0.75		0.85		0.84
Mean HSI Downstream Sites		= 0.81				

TABLE 19
BULLHEAD
BASELINE DATA FOR SITES E, F AND G
WITHOUT PROJECT DOWNSTREAM OF HODGES VILLAGE DAM

	E		F		G	
Model Variables (Condition)	Value	SI	Value	SI	Value	SI
V1 % Pools	100	0.70	100	0.70	100	0.70
V2 %Cover	15	0.60	37.5	1.00	72.5	1.00
V3 Ave. Water Velocity (cm/sec)	4.0	1.00	2.8	1.00	7	0.94
V4 Max. Water Temp (^{o}C)	26.4	1.00	26.4	1.00	26.4	1.00
V5 Diss. O_2 (mg/l)	seldom<6	1.00	seldom<6	1.00	seldom<6	1.00
V6 pH	6.5-8.5	1.00	6.5-8.5	1.00	6.5-8.5	1.00
V7 Turbidity (ppm)	<25	0.70	<25	0.70	<25	0.70
V11 Substrate (pools)	*	0.50	*	0.88	*	0.88
V12 % Cover (embryo)	21.25	1.00	43	1.00	76.3	1.00
Life Requisite Components						
Food		0.65		0.84		0.84
Cover		0.75		0.89		0.87
Water Quality		0.95		0.95		0.95
Reproduction		0.76		0.85		0.85
Habitat Suitability Index		0.71		0.88		.88
Mean HSI Downstream Sites			= 0.82			

* Resultant SI computed from a weighted mean of four transects.

TABLE 20
HABITAT UNITS (HU) WITH PROJECT WITHOUT WILDLIFE MITIGATION
FOR THE BASELINE AND TARGET YEARS FOR THE UPSTREAM LACUSTRINE
STUDY AREA

Upstream

Target Year	Area (Acres)	HSI	HU	YEARS	HU-Years	AAHU
	Largemouth Bass					
Baseline	11	0.83	9.13	-	-	
1	120	0	0	0-1	0	
5	120	0.70	84.00	1-5	168.00	
100	120	0.76	91.20	5-100	8322.00	85.76
	Bluegill					
Baseline	11	0.82	9.02	-	-	
1	120	0	0	0-1	0	
5	120	0.67	80.40	1-5	160.80	
100	120	0.85	102.00	5-100	8664.00	89.14
	White Sucker					
Baseline	11	0.83	8.91	-	-	
1	120	0	0	0-1	0	
5	120	0.67	80.40	1-5	160.80	
100	120	0.97	116.40	5-100	9348.00	96.05
	Bullhead					
Baseline	11	0.87	9.57	-	-	
1	120	0	0	0-1	0	
5	120	0.40	48.00	1-5	96.00	
100	120	0.80	96.00	5-100	6936.00	70.06

TABLE 21
HU's AND AAHU's WITH PROJECT WITHOUT WILDLIFE MITIGATION
FOR BASELINE AND TARGET YEARS FOR THE DOWNSTREAM STUDY AREA

Target Year	Area (Acres)	HSI	HU	Year	HU-Years	AAHU
	Largemouth Bass					
Baseline	17	0.89	15.13	-	0	
100	17	0.89	15.13	0-100	1513	15.13
	Bluegill					
Baseline	17	0.85	14.45	-	0	
100	17	0.85	14.45	0-100	1445	14.45
	White Sucker					
Baseline	17	0.81	13.77	-	0	
100	17	0.81	13.77	0-100	1377	13.77
	Bullhead					
Baseline	17	0.84	14.28	-	0	
100	17	0.84	14.28	0-100	1428	14.28

TABLE 22
CHANGE IN AVERAGE ANNUAL HABITAT UNITS (AAHU)
WITH PROJECT WITHOUT WILDLIFE MITIGATION

Upstream	Species	AAHU with project	AAHU without project	Change AAHU
7	Largemouth bass	85.76	9.13	76.63
	Bluegill	89.14	9.02	80.12
3	White sucker	96.05	8.91	87.14
7	Bullhead	70.06	9.57	60.49
2	TOTAL	341.01	36.63	304.38
Downstream				
	Largemouth bass	15.13	15.13	0
	Bluegill	14.45	14.45	0
	White sucker	13.77	13.77	0
	Bullhead	14.28	14.28	0
	TOTAL	57.63	57.63	0

TABLE 23
HABITAT UNITS (HU) WITH PROJECT WITH WILDLIFE MITIGATION
FOR THE BASELINE AND TARGET YEARS
FOR THE UPSTREAM STUDY AREAS

Target Year	Area(acres)	HSI	HU	Years	HU-Years	AAHU
	Largemouth Bass					
Baseline	11	0.83	9.13	-	-	
1	127	0	0	0-1	0	
5	127	0.70	88.90	1-5	177.80	
100	127	0.76	96.52	5-100	8807.45	90.76
	Bluegill					
Baseline	11	0.82	9.02	-	-	
1	127	0	0	0-1	0	
5	127	0.67	85.09	1-5	170.18	
100	127	0.85	107.95	5-100	9169.40	94.34
	White Sucker					
Baseline	11	0.83	8.91	-	-	
1	127	0	0	0-1	0	
5	127	0.67	85.09	1-5	170.18	
100	127	0.97	123.19	5-100	9893.30	101.65
	Bullhead					
Baseline	11	0.87	9.57	-	-	
1	127	0	0	0-1	0	
5	127	0.40	50.80	1-5	101.60	
100	127	0.80	101.60	5-100	7239.00	74.15

TABLE 24
CHANGE IN AVERAGE ANNUAL HABITAT UNITS (AAHU) WITH
PROJECT WITH WILDLIFE MITIGATION FOR THE UPSTREAM STUDY AREA

Species	AAHU with project	AAHU without project	Change AAHU
Largemouth bass	90.76	9.13	81.63
Bluegill	94.34	9.02	85.32
White sucker	101.65	8.91	92.74
Bullhead	74.15	9.57	64.58
TOTAL	360.90	36.63	324.27

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APPENDIX C

FINAL REPORT ON THE INTENSIVE ARCHAEOLOGICAL RECONNAISSANCE OF THE HODGES VILLAGE LOW FLOW AUGMENTATION IN OXFORD, MASSACHUSETTS

FINAL REPORT ON THE INTENSIVE ARCHAEOLOGICAL RECONNAISSANCE OF THE HODGES VILLAGE LOW FLOW AUGMENTATION PROJECT IN OXFORD, MASSACHUSETTS

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Contents

Abstract

An Intensive Archaeological Reconnaissance of the proposed Hodges Village Low Flow Augmentation Project in Oxford, Massachusetts was conducted by the Office of Public Archaeology at Boston University for the Department of the Army Corps of Engineers, New England Division. The intensive survey consisted of background research, field reconnaissance, and subsurface testing.

Background research identified no prehistoric sites in the vicinity of the project area. One post-1938 residential site was identified within the impact area. Surface reconnaissance and subsurface testing produced a thin scatter of historical artifacts. No evidence of prehistoric activity was encountered.

It is concluded that no significant cultural resources will be impacted by the present project. No further archaeological work is recommended.

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Acknowledgements

The Project Archaeologist wishes to express his gratitude to several individuals who contributed to the archaeological survey of the Hodges Village Low Flow Augmentation Project. Mr. John Wilson and Dr. Gary Sanford provided information relating to the nature of the proposed project and to the ecology of the impact area. Field testing was conducted with the assistance of Keith Adams, Erika Albert, Patricia Crawford, Judith Dolan, Deborah Durham, and John Shea. Dr. Ricardo J. Elia offered welcome professional advice and edited the report.

INTRODUCTION

An Intensive Archaeological Reconnaissance of land scheduled to be inundated by the Hodges Village Low Flow Augmentation Project in Oxford, Massachusetts was conducted by the Office of Public Archaeology (OPA) at Boston University. The project is being directed by the U.S. Army Corps of Engineers, New England Division. The archaeological survey was conducted in accordance with environmental and preservation legislation in order to evaluate the potential impact of the project on cultural resources within the project area.

Fieldwork for the archaeological survey was conducted in August, 1983. J. Cooper Wamsley served as Project Archaeologist, conducted prehistoric and historical research, supervised the fieldwork, and wrote the report. Dr. Ricardo J. Elia supervised the overall project and edited the report.

Project Area: Construction Impact

In 1959 the U.S. Army Corps of Engineers constructed the Hodges Village Dam in Oxford, Massachusetts, as part of a project designed to control flooding of the Thames River Basin. As part of that project, a 2,050 foot long dam and four earth dikes were built in order to allow for the inundation of land adjacent to the French River, north of Hodges Village (Fig. 1).

The Hodges Village Low Flow Augmentation Project, currently under study, will involve the creation of a seasonal reservoir that would cover a minimum of 90 acres at an elevation of 472.0 feet, and a maximum of 200 acres at an elevation of 475.6 feet. The purpose of this project is to improve the water quality of the area by augmenting summer flows with high quality releases from the reservoir. Project implementation will require the clearing of approximately 160 acres in the reservoir, along with the removal of organic soils in some places (Department of the Army 1980: 8). The impact area for the archaeological survey is effectively all areas within the reservoir below an elevation of 476.0 feet.

Project Area: Physical Environment

The town of Oxford is located in the south-central part of Worcester County, approximately 11 miles south of Worcester and 50 miles west-southwest of Boston. The topography of the town is characterized by north-south trending hills to the east and west, geographically separated by a series of plains in the central part of town. Low areas containing small water courses, ponds, wetlands, and meadows are interspersed between these features. Elevations range from approximately 450-850 feet.

The dominant drainage system of the town is associated with the French (Maanexit) River, which flows north-south and parallels the town's main street, located about one mile east of the river. The largest tributary of the French River in Oxford is Little River, located west of Oxford Center, which flows in a southeasterly direction. Mill Brook, another large tributary, flows from the northeast part of town to the southwest, where it joins the French River. The French River flows into the Quinebaug River, which joins the Thames River at Norwich, Connecticut. The Hodges Village Low Flow Augmentation Project involves the impoundment of water north of Hodges Village, located along the French River northwest of Oxford Center.

The bedrock geology of the area is characterized by metamorphic and igneous rock formations, with phyllite and schists predominating. Granite also occurs in abundance along with some gneiss, quartzite, and amphibolite (Cameron

1976: 352-363; Crane 1924: 4; Department of the Army 1980: 5; Emerson 1917: 68, 228; Perry and Emerson 1903: 4, 136, 155).

Pleistocene glaciation sculpted the terrain of this area and left soils composed mainly of ice-contact stratified drift and alluvium. Soils are generally of moderate agricultural utility. Hilly areas have been traditionally productive for fruit growing, grazing, and for hay. The alluvial plains of Oxford constitute the most fertile areas in the region, and have been used for growing garden vegetables, grapes, strawberries, and other small fruits (Daniels 1892: 3). The glacial alluvium and drift have supported several gravelling operations within the vicinity of the project area in recent times (Department of the Army 1980: 5).

Oxford has an average annual precipitation of 42 inches per year. Temperatures range from an average of 70 degrees F in July and August to 24 degrees F in January and February (Ibid.: 4-5).

One of the most attractive aspects of the area for early historical settlement was the proliferation of hay-yielding meadows. Many of these have since become forested or plowed farmland, although traces of these meadows still exist in the area (Daniels 1892: 2).

Two large cedar swamps located within the original boundaries of Oxford were also of economic importance during the Historical Period. Fencing material, clapboards, and shingles were derived from these areas (Ibid.: 3). One of these swamps, Little Cedar Swamp, is adjacent to the northeast edge of the project area (Fig. 10).

A detailed description of the physical environment of the impact area of the project will be presented in the Field Reconnaissance section of this report.

BACKGROUND RESEARCH

Prehistoric Period

Little is known about the prehistoric occupation and utilization of the Oxford area. No prehistoric sites have been systematically excavated within the town, and, although a number of sites have been recorded in the area, most are lacking cultural and chronological data. Collecting has apparently been minimal, and no prehistoric collections are available for examination at the present time. The town library once had a collection of prehistoric artifacts from the area, but the collection was stolen five years ago and has not been recovered. In view of this lack of systematically obtained data for the prehistory of the town, archaeological expectations for the project area can be formulated on the basis of information derived from other areas in the region, and from the limited information available for Oxford.

Compared with surrounding towns, relatively few prehistoric sites are known in Oxford. Within a 7.5 mile radius of the project area, 39 prehistoric sites are recorded in the site files of the Massachusetts Historical Commission. Of these 39 sites, only 3 are recorded within the town of Oxford. Two other sites are reported in the town by David Anthony (1978: 54). This relatively small number of reported sites probably reflects the paucity of collecting and reporting in the area rather than actual prehistoric site densities.

There is no reason to believe that Oxford, with its ponds, streams, wetlands, plains, and upland areas, would have been less attractive to prehistoric settlement than surrounding areas. The French River Basin would have supported numerous floral and faunal resources, including anadromous fish, migratory waterfowl, and other mammalian, amphibian, reptilian, and floral species, as it still does today (Dr. Gary Sanford: personal communication). Oxford's fertile plains could have been easily cultivated by Woodland Period Indians (c. 3000 BP-1630 AD).

Prehistoric site locations in Oxford and the surrounding area reflect the locational characteristics of sites in Worcester County generally, as reported by Anthony (1978: 43-46). Four of the five known sites in Oxford are located on or within 100 feet of ponds. A total of 63% of sites recorded within a 7.5 mile radius of the project area are located on or near pond shores, indicating a probable preference for settlement along these bodies of water (cf. Anthony 1978: 45). Other sites in the area were located along streams, adjacent to wetlands, and on hill slopes (MHC Files).

There is little evidence for the prehistory of the Thames River drainage in Massachusetts. Sites with known cultural affiliations are rare due to the generally haphazard nature of the available data. The earliest evidence of prehistoric occupation comes not from the Thames River drainage, but from the Mill River site in Mendon, located about 15 miles east of Oxford. Here, a fluted point, characteristic of the Paleo Indian Period (c. 12,000-10,000 B.P.) was found in an Early Archaic (c. 10,000-8,000 B.P.) context. This site, which also contains evidence for Middle Archaic occupation, provides the best information available at the present time for the earliest human occupation of the area (Thomson 1978: 3-4).

The Late Archaic Period (c. 6,000-3,000 B.P.) in the area is characterized by a quantitative increase in sites and site habitats over previous periods. Sites recently excavated by the Public Archaeology Laboratory in nearby Sutton and Uxbridge date to this period (Thorbahn and Cox 1983). Evidence from these sites, including the Cracker, Purgatory I, and Purgatory II sites, suggests that portions of the inland territories were being utilized on an occasional or seasonal basis, rather than being permanently occupied (Ibid.: 122).

Other recorded Late Archaic sites in the vicinity of the project area include 19-WR-111, 19-MM-148, and 19-MM-149 in Millbury. Sites of this period within Oxford include 19-WR-57, at Slaters Pond, located about 2.5 miles east of the project area, as well as sites on Fort Hill, about 2.5 miles southeast of Hodges Village (Anthony 1978: 54, Appendix B). A number of Late Archaic artifacts are shown in a photograph of the collection that was recently stolen from the town library (Daniels 1892: 42).

Woodland Period (c. 3,000 B.P.-1630 A.D.) sites in the area frequently occur at locations occupied by Late Archaic peoples, for example at the Slaters Pond site and the sites on Fort Hill (Anthony 1978: 54, Appendix B). Aboriginal ceramics, a hallmark of the Woodland Period, have been found at a site in nearby Millbury (19-WR-85).

No recorded prehistoric sites exist within the project area. The closest reported site is near Buffum Pond (19-WR-76), about one mile west of the project area; very little cultural or chronological information is known for this site. Although the project area has included a pond throughout the historical period (e.g., Fig. 4), this pond was an artificial creation and was therefore not present during the prehistoric period. The French River would have flowed freely through the area, although changes in its course appear to be documented by deep post-glacial alluvial deposition that was identified in subsurface testing. When the water table permitted, this alluvium was removed in order to locate deeply buried sites. Many Early and Middle Archaic sites are thought to exist below these types of deposition (Dincauze and Mulholland 1977: 454).

The cedar swamp near the project area (Fig.10) existed at the time of contact (Daniels 1892: 3), and would have provided numerous wetland resources, including migratory waterfowl and amphibians. The resources associated with the wetlands along the French River would have made this area an attractive locale for exploitation during most of the prehistoric period.

Contact Period

At the time of contact, the area of Oxford belonged to the Nipmuck Indians, a group of loosely related, village-based bands, each with its own sachem. Each band paid tribute to more powerful neighbors for protection against hostile tribes (DeForest 1964: 57; Salisbury 1974: 36-37; Salwen 1978: 174). The Nipmucks inhabited central Massachusetts and northeastern Connecticut (Ayres 1940: 172; Connole 1976: 14; Cook 1976: 53; Daniels 1880: 17; Sylvester 1910: 451). A Praying Indian village was located about five miles east of the project area at Manchaug, and another was located about five miles south at Chaubunagungamaug (Gookin 1792: 189-190). Daniel Bondet, the first Huguenot minister in Oxford, was a missionary to the local Nipmucks under the authority of the Society for the Propagation of the Gospel in New England (Daniels 1880: 76; 1892: 22; Holmes 1826: 364). Praying Indian villages were created to "civilize the savages," thus reducing the threat of Indian uprisings and paving the way for colonial expansion (Jennings 1971: 197-212; Salisbury 1974: 28).

A Contact Period burial ground is located on the Northside Turnpike in Charlton (19-WR-248). Another site, probably dating to the Contact Period, is located on Lowes Pond, about 1.5 miles southeast of the project area (Anthony 1978: 54).

Historical Period

A broad range of primary and secondary documentary sources was consulted during the background historical research for this project. Primary sources, reposited in the Massachusetts State Archives and the Oxford Public Library, included county atlases, town maps, and several documents relating to the early history of the town. Secondary sources included the architectural and National Register of Historic Places files at the Massachusetts Historical Commission in Boston. Town and county histories comprised the remainder of the secondary sources examined.

Oxford was settled in 1686 by a group of approximately 30 Huguenot families under the direction of Gabriel Bernon, a wealthy Huguenot merchant from La Rochelle, France. Bernon had purchased the land in the Nipmuck country from Robert Thompson, Joseph Dudley, and William Stoughton, who had obtained a grant for the town in 1683. The Huguenot colony thrived during the first eight years of settlement; in that period, a grist mill, sawmill, church, houses, and fort were built. The young colony was threatened in 1694 by a group of hostile Indians, who forced the colonists to retreat to their fort on Fort Hill for a period of three months while their crop went unattended.

In 1696 an Englishman named John Johnson and his three children were massacred by a band of Albany Indians. Johnson's Huguenot wife escaped unharmed to Woodstock with the help of Daniel Johonnot, her cousin. The remainder of the Huguenot group abandoned the settlement and fled to Boston. By 1699, eight to ten Huguenot families attempted to reestablish the community, and set up a wash-leather mill (a mill with a large, water-driven, hammer-like apparatus used to tenderize leather) by 1703. Finally, in 1704, these French Calvinists were once again forced by the Indians to abandon Oxford; this time they never returned (Ammidown 1877: 106-171; Crane 1924: 53-56; Daniels 1880; 1892: 5-31).

Oxford was not permanently settled until 1713, when about thirty English colonists received home lots on or near the fertile "Great Plain" near the middle of the present town. Each landholder was given an equal portion of land from Oxford's meadows and cedar swamps (Daniels 1892: 36-37).

The Indians did not pose much of a threat to the new English settlement, "although at times they prowled about the borders of the village, stealing pigs, chickens, garden vegetables, etc." (Daniels 1892: 42). According to tradition, there were two garrison houses in the town, although no documents exist to support this assertion (Ibid.).

During its first century of settlement, Oxford's population grew steadily as the local economy was dominated by agricultural pursuits. As the 18th century progressed, new homesteads took advantage of fertile areas other than those on the Great Plain, and settlement became less nucleated. Oxford's hills were good for grazing and fruit growing, while vegetable and small fruits were grown on its plains (Daniels 1892: 3). Population grew from 890 persons in 1764 to 1,112 in 1776. By 1790 the population dropped to 1,000, but rebounded to 1,273 in 1800.

The first grist mill operated by the English colonists was that of Daniel Eliott. By the time Eliott sold the mill located along Mill Brook in 1720, a sawmill had been added to the site. Milling on this privilege probably continued through 1792 (Ibid.: 189).

Prior to 1800, the most important exported manufacture of the town was potash. Six potash factories existed in Oxford during the 18th century (Ibid.: 188; 1794 Map).

Around the turn of the 19th century, Oxford's economy became increasingly diversified. Around 1793 a trip-hammer forge was established on Bugs Pond Brook for the production of scythes. This operation was defunct by 1831 (Daniels 1892: 190; 1794 and 1831 Maps). Nails were being wrought by 1792 near Saccarappa Pond. From 1798 to 1805, bar iron was manufactured in South Oxford, now East Village in Webster. Around 1810 a distillery was operating near Carbuncle Pond, but this industry lasted only three years. Another important 19th-century industry was brickmaking. This industry was well established by the turn of the century, although its 18th-century origins are uncertain. Chaises and harnesses were also being manufactured at the south end of the Great Plain by 1828 (Daniels 1892: 188-215). Oxford also had a strong 19th-century shoe industry (Ibid.: 216-219; Crane 1924: 101).

The most significant business venture in the history of the town was the construction of a series of mills in South Oxford under the supervision of Samuel Slater. "No event in the history of the town, viewed from a business standpoint, was so far-reaching and important in its results as that of the beginning of manufacturing at South Oxford by Mr. Slater" (Daniels 1892: 190). Slater eventually purchased all of South Oxford and controlled major privileges along Mill Brook. In 1812 he constructed Green Mill here and began spinning wool; power weaving was introduced here in 1824. Slater's mill complex in South Oxford helped to mobilize public efforts to create the town of Webster in 1832 from part of Oxford (Ibid.: 190, 198).

North Oxford, Larned Village, and Hodges Village were thriving 19th-century mill villages that grew out of 18th-century milling activities. Milling began at Buffumville, another large village, by 1812 (Ibid.: 202). The project area is located north of Hodges Village, and includes the water seat from which its mills operated. For this reason, the historical development of Hodges Village will be treated separately below.

Population in the 19th-century town of Oxford reflected changes in political boundaries as well as growth and decline of local industry. From 1800 to 1830 Oxford's population steadily increased from 1,273 to 2,034, reflecting early mill development in villages such as South Oxford. The creation of Webster out of South Oxford explains the population drop to 1,742 in 1840. From 1840 to 1860 the population grew to 3,034 and then fell to 2,669 in 1870. Another peak was reached in 1875 at 2,938, followed by a decrease to 2,355 in 1885. This change was due to a depression that struck Oxford's shoe industry. By 1890, population was again on the rise in the town (Daniels 1892: 269; Hurd 1889: 1317).

During the 20th century, industries declined and shut down, as Oxford remained a largely rural community. Much of the town today is wooded or under cultivation. As of 1980, the only manufacturing concerns were two woolen mills. Gravel pits provide some income, and the town is now constructing an industrial park to encourage new industry. In 1975 Oxford's population was 10,822, an increase of 17% from 1960 (Department of the Army 1980: 7). Population will probably continue to grow as Oxford becomes a bedroom community for nearby Worcester.

The birthplace of Clara Barton and the Hudson House are the only structures in Oxford listed on the National Register of Historic Places. The Clara Barton homestead is located at the northwest corner of Clara Barton Road and Ennis Road. The Hudson House, a farmhouse built in 1720, is situated on Hudson Road next to Hudson Pond. Oxford also claims to have the oldest Universalist Church in the country, located on Main Street (MHC Files).

<u>Historical Development of Project Area and Vicinity</u>

Hodges Village, located immediately south of the project area, has a long history of milling activity. In 1722, this site was sold by Abraham Skinner, an original proprietor, to Thomas Gleason, who built a grist and saw mill here by 1732. By 1794, the site was still occupied by a grist and saw mill (Fig. 2). Power weaving began here by 1822, but, by 1824 the mills were bought by Samuel Slater, who moved them to South Oxford. By 1825, a company led by Delano Pierce, Richard Olney, Stearns Witt, and Samuel Dowse bought the mill site, and constructed a new dam and mill building for the manufacture of woolen material. A minor change of ownership occurred in 1826, when the Oxford Woolen Manufacturing Company was organized and began operation. This company continued to produce wool flannel until 1846, when the entire mill complex was sold to George Hodges, Jr., who owned and operated it until his death in 1881. Andrew Howarth took over operations in 1882 and continued producing wool flannel here through 1920 (Crane 1924: 95).

Mill power at Hodges Village was derived directly from the French River. An apparently natural pond is shown at Hodges Village on the 1794 map, but the mill power seat for the village was located upstream from this pond (Figs. 2, 3), which apparently never functioned as a power source. The 1870 map shows a large impoundment in the project area above the power seat (Fig. 4). Maps prior to 1870 are inconsistent in indicating town ponds, and it is possible that a smaller pond in the area served as a power source for the early saw and grist mills. Nevertheless, by 1870, the impoundment was certainly the source of power for the 19th-century woolen mill.

According to information gleaned from historical maps, settlement in the project impact area occurred after 1938

(1938, 1956 Maps). Between 1938 and 1956, a house was constructed on the east side of Old Howarth Road, approximately 2,000 feet south of its intersection with Old Charlton Road (1956 Map). Several 19th-century farmsteads were located adjacent to the project impact area (Fig. 4), but these are not threatened by current development plans. No extant structures exist within the project area.

Approximately 600 feet north of the modern house adjacent to the project area is a low area that has served as a dumping site during the 20th century. The modern dump is located within the project area, and was probably used by residents in the vicinity of the project area. Several gravel pits flank or extend into the project area, although no gravel pits located within the project area are currently in operation.

The modern road system in the vicinity of the project area appears as early as 1831 (Fig. 3). Old Howarth Road flanks the project area on the east (Fig. 8). Old Charlton Road runs in an east-west direction and divides the project area approximately 1.2 miles north of the Hodges Village Dam. The Old Charlton Road Bridge, which once crossed the French River, was probably removed when the land was taken by the Federal government (Mr. John Wilson: personal communication; Fig. 6).

The Boston and Albany Railroad once ran in a north-south direction through the western part of the project area. This railroad appears for the first time on the 1898 map and was still functioning in 1956 (1898, 1956 Maps). The railroad tracks were removed soon after 1956 and the railroad bed was converted into a service road for the high tension utility line that runs through the area today (Fig. 1).

Today the project area is used for recreational activities in addition to its primary function as a flood control area. Hunting, hiking, and snowmobiling take place within its boundaries. Two recreational areas, including playing fields and tennis courts, are situated near the project area on land owned by the U.S. Army Corps of Engineers and leased to the town. Since the construction of the dam in 1959, water has been impounded in the project area when it is required for flood control. During periods of heavy rainfall, the dam is used to control water flow below Hodges Village (Mr. John Wilson: personal communication).

FIELD INVESTIGATIONS

The archaeological investigation of the proposed Low Flow Augmentation Project was intended to satisfy the requirements of a Phase I, Step 2 (Intensive) cultural resources survey as outlined by the Massachusetts Historical Commission (MHC 1980: 9-10). The intensive archaeological survey is aimed at locating and identifying archaeological sites within the anticipated impact area of a project. The impact area of the present project involves approximately 200 acres of lowlands below the 476.0 elevation. Field investigations consisted of a pedestrian inspection of the project area and subsurface testing.

Field Reconnaissance

The purpose of the walkover survey was to visually assess the nature of the impact area and to identify archaeological sites by surface inspection. The field reconnaissance also served to evaluate the suitability of the project area for subsurface testing on the basis of actual field conditions, including such factors as drainage, slope, terrain, and disturbance.

The impact area was delineated with the assistance of a 1:2400 scale U.S. Army Corps of Engineers topographical plan.

The 476.0 elevation was marked onto this plan by extrapolation and by field survey data furnished by Dr. Gary Sanford, who conducted ecological research in the project area prior to the archaeological survey. The topographical plan with the impact area marked on it was then used as a field map for the surface reconnaissance and subsurface testing.

Although the total impact area involves some 200 acres, the majority of this acreage consists of areas of standing water and swampland that was not testable due to poor drainage and mucky soils (Fig. 7). Characteristic vegetation in the project area includes Atlantic White Cedar, Red Maple, White Pine, Northern Red Oak, and Gray Birch, as well as low scrub vegetation. The wet soils in the impact area also support wetland plants such as ferns, mosses, and pitcher plants (Department of the Army 1980: 10).

The walkover survey demonstrated that portions of the impact area that were accessible for archaeological testing were consistently located near the 476.0 contour line. The archaeologically sensitive areas, in fact, consisted primarily of a narrow strip of relatively well drained land running around the perimeter of the reservoir area. Below this strip, the terrain was uniformly wet. Although the background research identified no prehistoric sites within the project area, well drained, relatively level portions of the impact area were considered archaeologically sensitive for the presence of prehistoric sites. This calculation of sensitivity was based on the supposition that dry areas on the margins of the French River and its associated wetlands would have been attractive locations for resource exploitation during the prehistoric period. Any archaeological sites located in these areas would probably be small, temporary or seasonal campsites. No significant historical period sites were anticipated along the low-lying areas of the project zone, although traces of historical material derived from sites located at higher elevations outside the project area were expected.

Based on the results of the walkover reconnaissance, a total of 12 sections of the impact area were identified as moderately sensitive for prehistoric sites, and were scheduled for subsurface testing. These areas are shown in Figures 8-10. Sections 1, 2, 4, and 10 are small, natural peninsulas flanked by swampland or the French River. Sections 3, 8, 11, and 12 consist of land bordering between swamp and upland or river and upland. Sections 5,6, 7, and 9 are low, dry, inlet areas. All areas identified for testing are located along the edge of the area that will be impacted by the proposed project.

Subsurface Testing

The 12 areas identified during the field reconnaissance as archaeologically sensitive were tested by means of shovel test pits. A total of 124 test pits were excavated during the intensive survey. In general, test pits were excavated in transects running parallel to the long axis of the sensitive area. In order to test for the presence of small prehistoric sites, a sampling interval of 10 meters was employed in all areas except where otherwise indicated. The location of test pits is shown in Figures 8-10 .

The excavation units measured 50 x 50 cm. and were excavated to varying depths. Many of the units were located in areas that had been flooded and contained post-glacial silt and sand to a depth of c. 75 cm. In these areas, test pits were excavated to depths averaging over 100 cm. in order to test for cultural remains buried below the alluvial deposits. In several cases, high water table prevented further excavation. Other test units were located in higher areas that had not been subjected to recent flooding and silting; in such cases, excavation proceeded until sterile glacial subsoils were reached. All test pits were excavated by shovel to a depth of at least 50 cm. Soil horizons were sifted as distinct units through ¼-inch mesh screen, and all cultural materials were collected and recorded by unit and stratigraphic provenience. Test pit data, including stratigraphy, soil color, texture, and composition, were recorded for each unit on standardized field forms (See Appendix II).

A brief summary of the results of field testing is presented below. No prehistoric cultural materials were recovered in any of the test pits. A thin scatter of historical period artifacts was uncovered in several units (Appendix I).

Area 1 was located approximately 400 feet north of the Hodges Village Dam on the east side of the French River (Fig. 8). Test Pits 1-4 were placed along a north-south transect on a narrow section of land flanked by the swamp to the east and the river to the north and west. Red Maple and White Oak are the dominant forest species in this section. Testing produced only two redware fragments from the topsoil of Test Pit 2.

Area 2, located directly east of Area 1, was another small peninsula jutting into the swamp (Fig. 8). The vegetation here consists of American Elm and low brush. Test Pits 5-8 were excavated in a transect that bisected this area. These pits encountered a scatter of 19th- and 20th-century artifacts, probably reflecting broadcast scatter associated with nearby Old Howarth Road.

Area 3 was located about 1600 feet north of the dam on the east side of the swamp. Test Pits 10-15 were excavated in two transects within an area that forms a transition between swampland and higher ground to the east. No cultural remains were recovered in these test pits (Fig. 8).

Area 4 is a hook-shaped projection of low wetland that included some testable areas on its northern edge. This section, located some 600 feet north of Area 3, is bordered by swampland, the French River, and an upland area outside of the project area (Fig. 9). A transect including Test Pits 16-37 was excavated along a natural ridge adjacent to the French River. Alluvial silt and sand was encountered to levels below the present water table (c. 75 cm.) in most test units. All test pits in this section were devoid of cultural materials.

Area 5, located approximately 2,000 feet south of the intersection of Old Charlton Road and Old Howarth Road, comprises another transitional area between swampland and higher terrain (Fig. 9). Test Pits 38-41 were excavated in a transect placed east of Old Howarth Road. This transect was situated in the vicinity of a structure built by 1956 (1956 Map). An extant well was identified on the surface near Test Pit 17; no other above-ground remains of the recent structure were found in this area. No cultural materials were recovered from the test pits.

Area 6 was a V-shaped inlet on the east side of Old Howarth Road, about 1,600 feet from the intersection of that road with Old Charlton Road (Fig. 9). Test Pits 42-51 were excavated in an area of low brush and open field. A second transect, including Test Pits 52-57, was placed in a lightly wooded area that appeared to have served as a dump in this century. Several historical period ceramics were recovered in the test units; these probably are to be associated with the 20th-century dumping activities here.

Area 7 is located along a path that intersects with Old Charlton Road (Fig. 9). Test Pits 58-66 were excavated in this area. No cultural materials were encountered in these test units.

Area 8 comprised two natural ridges, one separating the French River from a swampy area, the other running perpendicular to the river (Fig. 10). The area is located at the junction of

Old Charlton Road and the east bank of the French River. The remains of a stone bridge are located at this point (Fig. 6). Two transects were placed in this section to test the two ridges. The first included Test Pits 67-75. Modern bottle glass was found in Test Pit 67 and an unidentified metal fragment and piece of brick were encountered in Test Pit 69. These artifacts probably represent a scatter of material derived from activity along Old Charlton Road. The second transect included Test Pits 76-81. Two sherds of whiteware, two bits of charcoal, and a brick fragment were recovered in Test Pit 81.

Area 9 is a small inlet area on the opposite side of the French River (Fig. 10). Test Pits 82-84 were excavated in this section. The test units were devoid of cultural materials.

Area 10 consists of two small north-south oriented peninsulas flanked by swampland (Fig. 9). Test Pits 85-89 were excavated along a transect on the easternmost of the two peninsulas. Test Pits 87 and 88 produced evidence of brick dumping. Test Pit 87 contained small pieces of brick, while whole bricks were found in Test Pit 88. The whole bricks were located randomly within the unit and no evidence of mortar was found. Many of the bricks appeared to be misformed wasters. No structures appear on any map in this vicinity, and it is likely that the area was used as a small dumping spot for the bricks.

Test Pits 90-99 were excavated on the westernmost peninsula in this section. No artifacts were found in any of these pits (Fig. 9).

Area 11 is located approximately 1,500 feet north of the Hodges Village Dam, in an area that forms a transition between swampland and upland terrain. Test Pits 100-109 were devoid of artifacts (Fig. 8).

Area 12 is located about 700 feet west of Area 11, and approximately 200 feet west of the old Boston and Albany Railroad bed (Fig. 8). This section is also transitional between swampland and upland areas. Test Pits 110-120 were located along a transect running parallel to the edge of the swampland. In Test Pit 119, a chunk of quartz was recovered along with 14 smaller quartz chunks. Although this material lacked well formed flakes, the density of quartz in this test pit suggested that the material might have been the result of cultural activity. The large chunk of quartz, in particular, suggested a possible prehistoric preform to the excavators in the field.

In order to further clarify the nature of this material, an additional four test units were excavated around Test Pit 119, at a distance of 5 meters from it (Fig. 8). No cultural materials were found in these test units (119a, b, c, d), or in any of the other test pits in this section.

Laboratory analysis of the quartz fragments recovered from Test Pit 119 indicated that the material was not culturally formed. The quartz is coarse, poor quality material that probably fractured naturally. The 14 small chunks reveal sharp, angular breaks suggestive more of natural fractures than human agency.

CONCLUSIONS AND RECOMMENDATIONS

The Phase I, Step 2 (Intensive) archaeological survey of the Hodges Village Low Flow Augmentation Project in Oxford, Massachusetts consisted of literature and document searches, field reconnaissance, and subsurface testing. Based on the background research and field reconnaissance, twelve sections of the impact area were identified as being moderately sensitive for the presence of prehistoric sites. These sections consisted of relatively dry areas along the margins of the French River and its associated wetlands.

A total of 124 shovel test pits were excavated during the intensive survey. No prehistoric artifacts were found in any of the test units. A scatter of late historical artifacts was found in several test pits, reflecting a thin scatter of debris associated with minimal activities in the impact area during the Historical Period.

The lack of prehistoric material is not surprising given the narrow, low-lying nature of most of the areas tested during the archaeological survey. These areas, consisting for the most part of small, marginal areas running around the perimeter of the reservoir, frequently proved to be poorly drained transitional areas between swamp or river and more well drained areas beyond the project's impact area. In most cases, more attractive areas for prehistoric occupation or utilization could be found just beyond the project area, which essentially includes all the naturally low areas that would normally be susceptible to flooding at various times during the year. This is also confirmed by the pattern of land use in the area during the Historical Period. With few exceptions, historical roadways and residences were located outside the impact area of the present project.

In view of the results of the archaeological survey, it is concluded that no significant archaeological resources are likely to be impacted by implementation of the Low Flow Augmentation Project. It is therefore recommended that the project be permitted to proceed without further archaeological study.

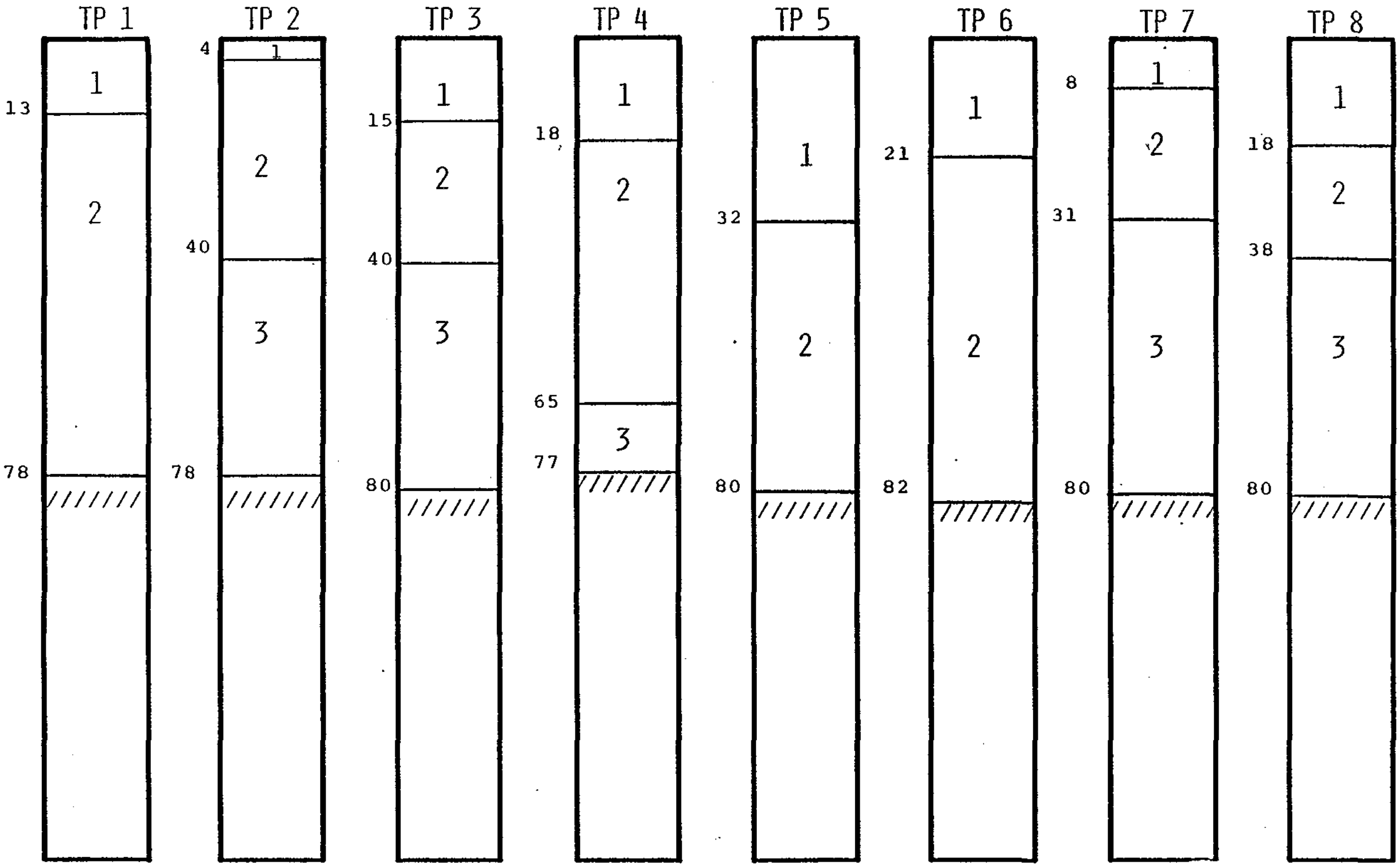
APPENDIX I: INVENTORY OF CULTURAL MATERIALS RECOVERED FROM TEST PITS

Test Pit	Level/Depth (cm.)	Artifacts
2	Topsoil: 0-4	2 redware frags.
5	Yellow-brown silty sand: 32-80	2 wire nail frags. 1 slag frag.
6	Topsoil: 0-21	3 redware frags. 1 brick frag. 1 earthenware frag. 1 pearlware frag. (c. 1780-1830) 1 tinted glass frag. (burned)
7	Topsoil: 0-8	1 clear glass frag. (modern)
8	Yellow-brown silty sand: 18-38	1 clear glass frag. (modern)
42	Topsoil: 0-10	1 pearlware frag. (c. 1780-1830)
43	Topsoil: 0-6	5 unidentified iron frags. 1 brick frag.
44	Gray mottled sand: 30-43	1 tinted glass frag. (modern)
45	Topsoil: 0-17	6 frags. tinted glass from molded bottle
47	Topsoil: 0-14	1 clear glass frag. 1 pearlware frag. (c. 1780-1830)
50	Topsoil: 0-15	1 pearlware frag. (c. 1780-1830)
51	Topsoil: 0-8	1 clay marble

Test Pit	Level/Depth (cm.)	Artifacts
53	Mottled silty sand: 2-22	1 earthenware frag.
56	Topsoil: 0-7	4 metal pieces to an electrical fixture 1 porcelain electrical insulator 9 frags. brown bottle glass
67	Topsoil: 0-11	2 clear bottle glass frags.
69	Topsoil: 0-38	1 oval metal ring (5 cm. max. width) 1 brick frag.
81	Topsoil: 0-15	2 whiteware frags. (c. 1820-1900) 1 brick frag.
87	Topsoil: 0-32	Numerous brick frags.
88	Topsoil: 0-50	Numerous bricks and brick frags.

APPENDIX II: TEST PIT STRATIGRAPHY

(Note: All depths in centimeters)

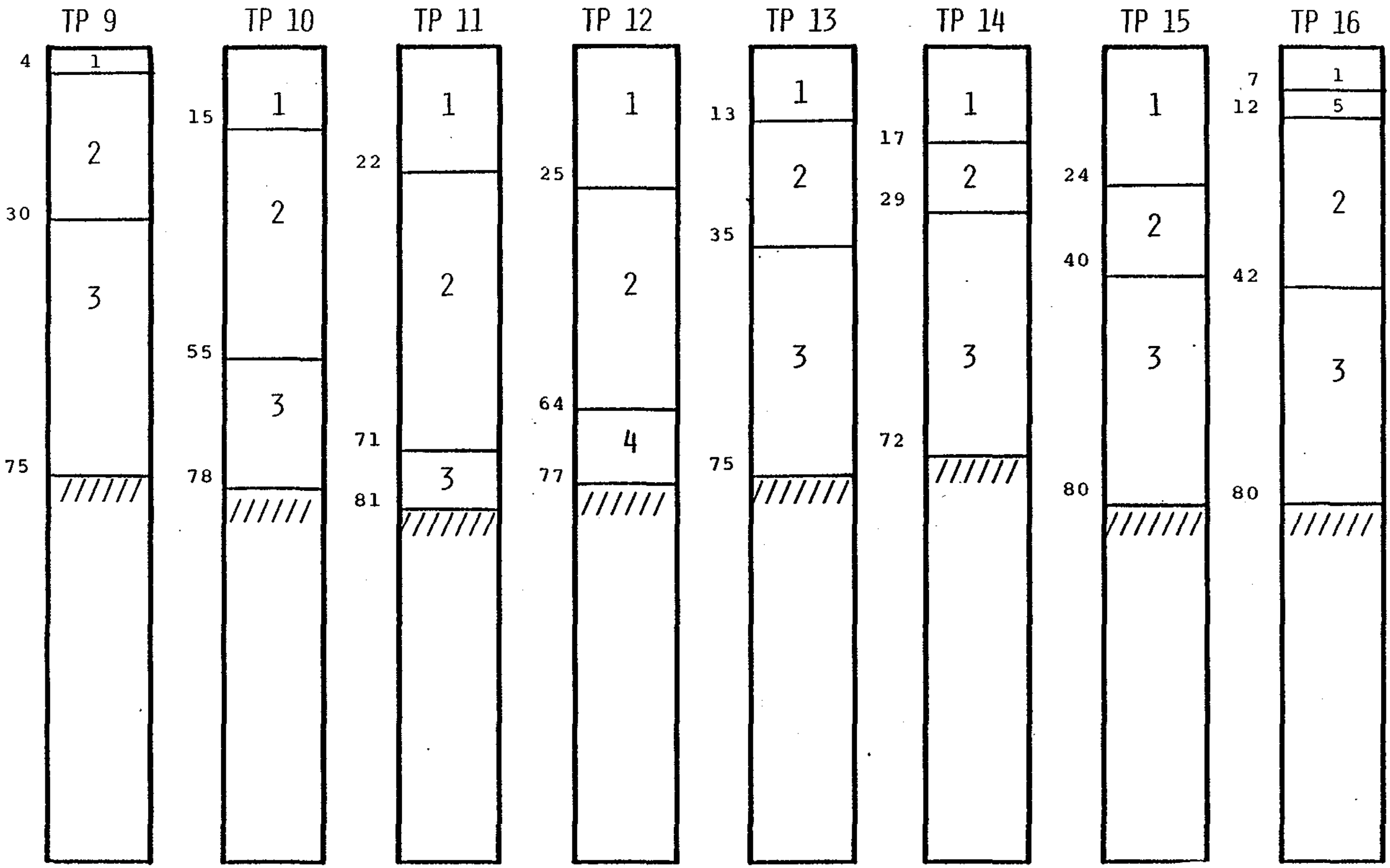


KEY: 1 Topsoil

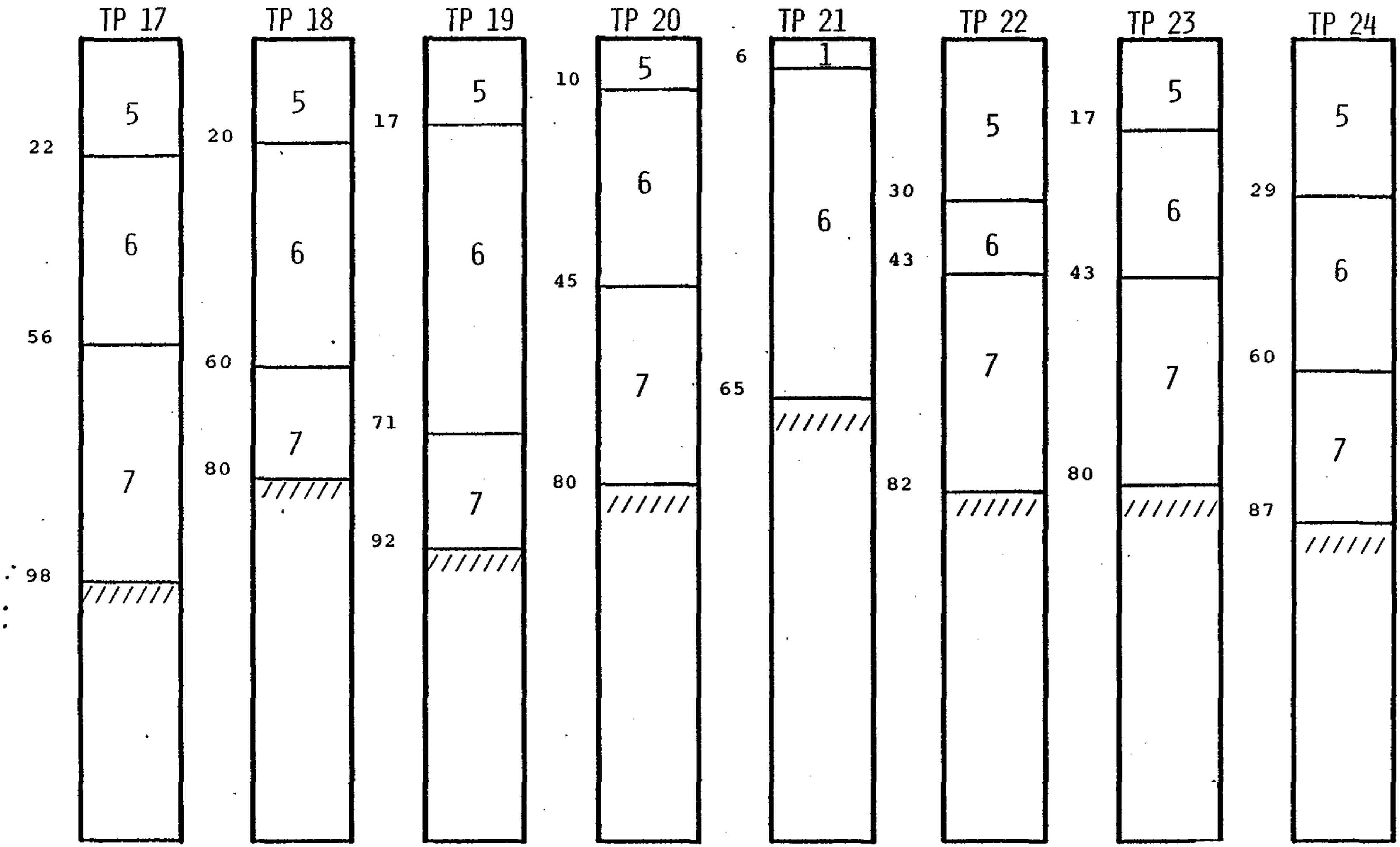
2 Yellow-brown silty sand

3 Yellow-gray silty sand

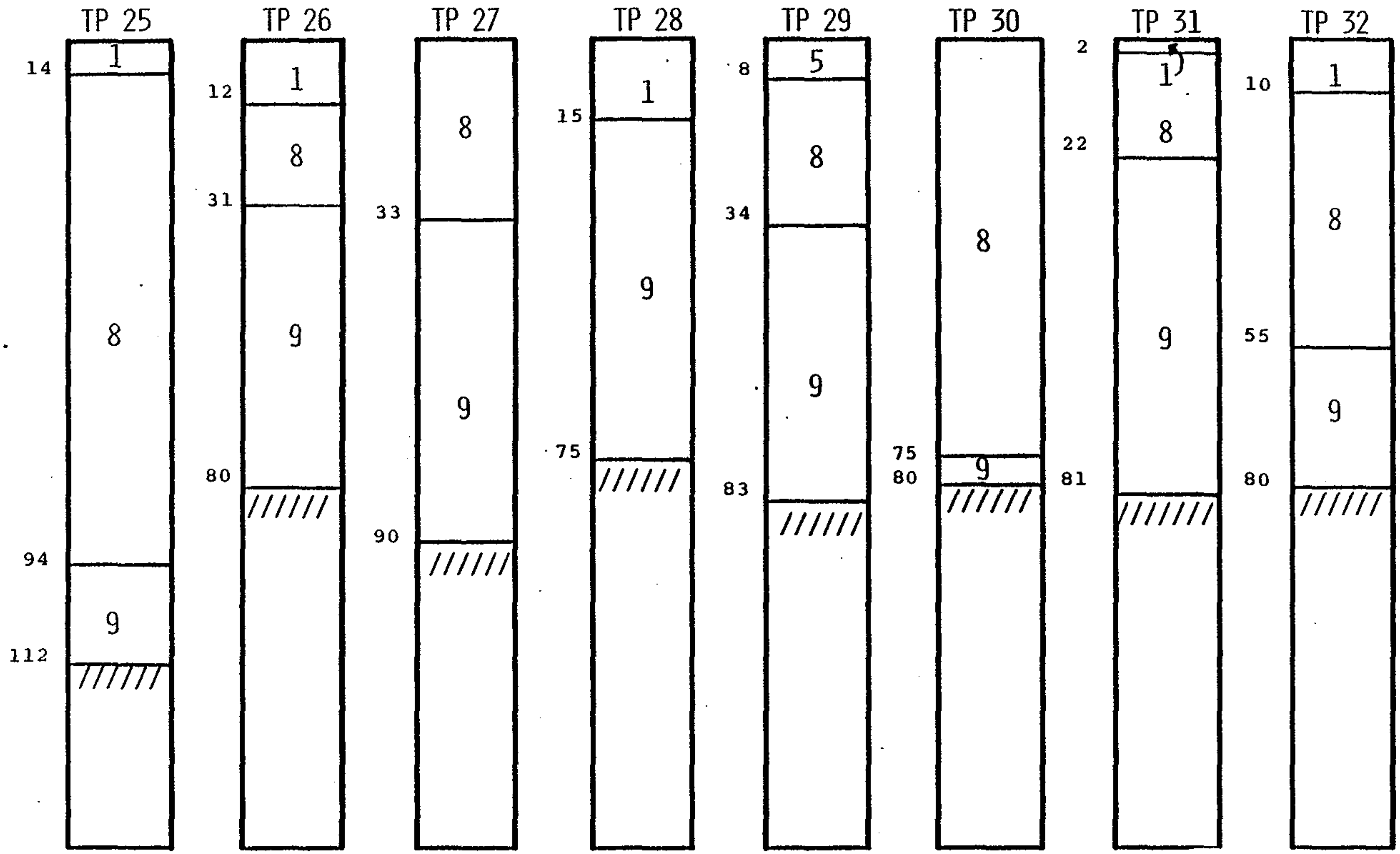
//// Unexcavated



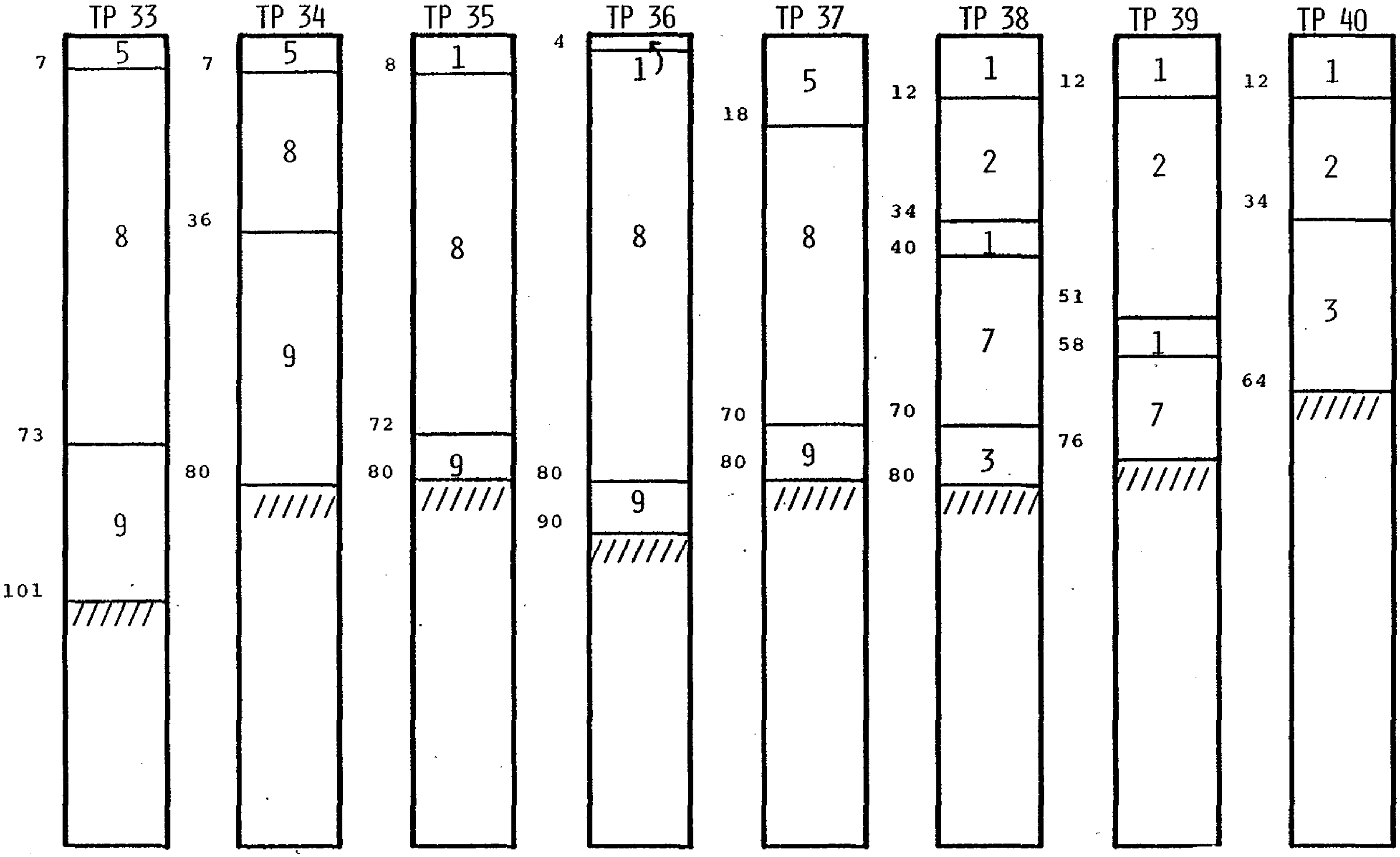
Key: 1 Topsoil
2 Yellow-brown silty sand
3 Yellow-gray silty sand
4 Gray sandy clay
5 Gray silty sand mixed with humus
/// Unexcavated



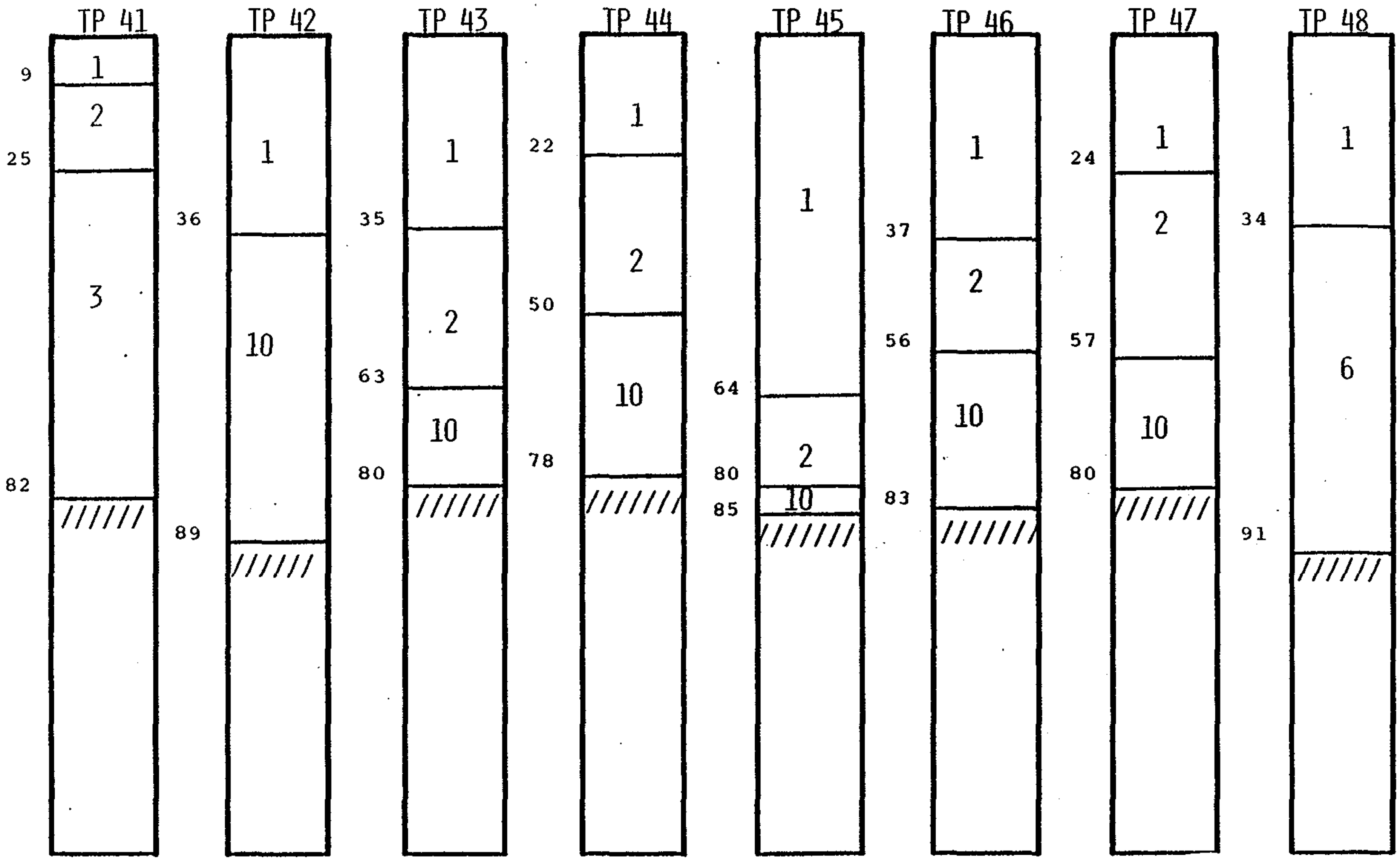
KEY: 1 Topsoil
5 Gray silty sand mixed with humus
6 Gray sand with yellow-orange mottle
7 Dark brown silty sand
//// Unexcavated



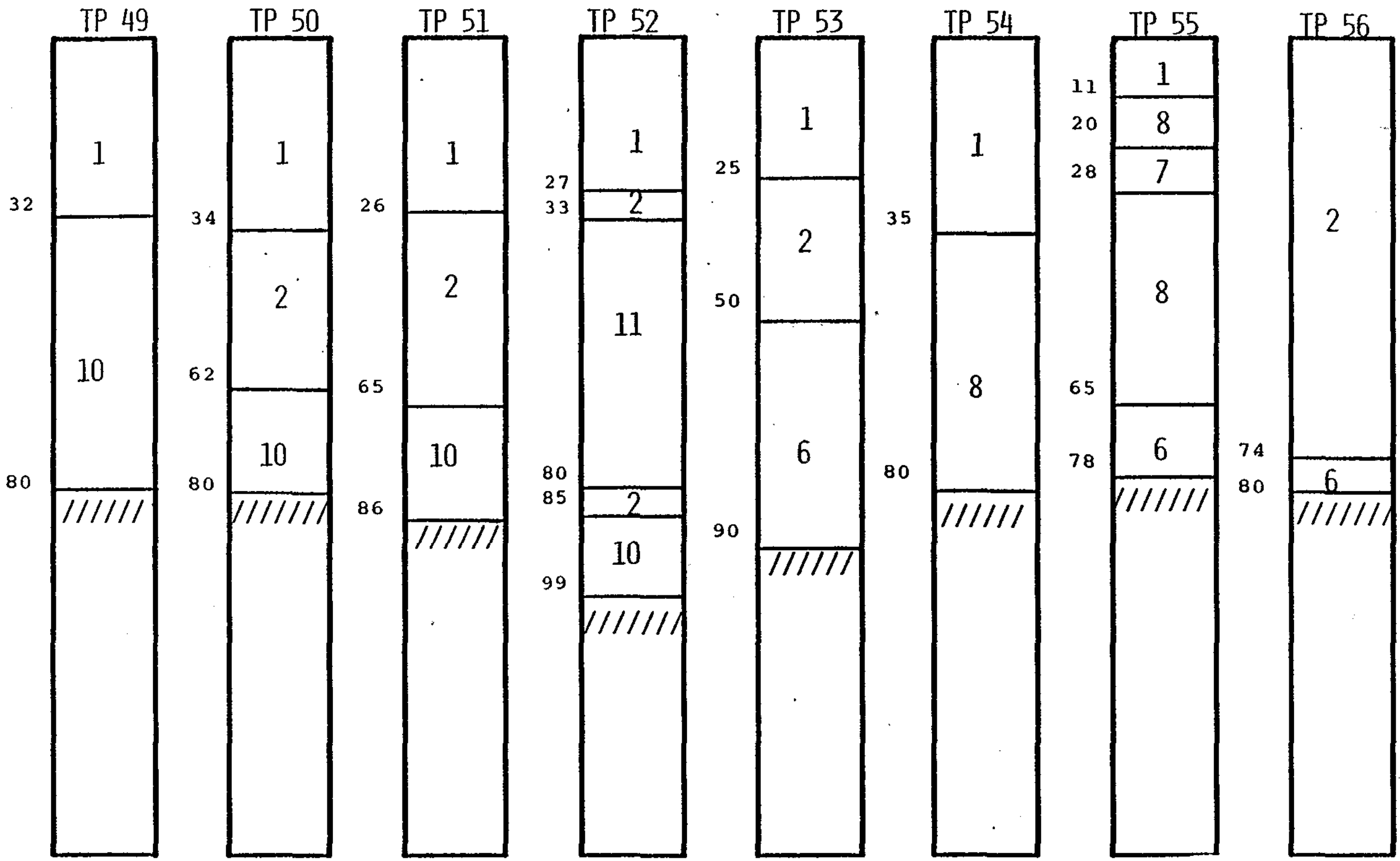
KEY: 1 Topsoil
5 Gray silty sand mixed with humus
8 Brown/tan/black mottled silty sand
9 Wet gray sand with organic material
/// Unexcavated



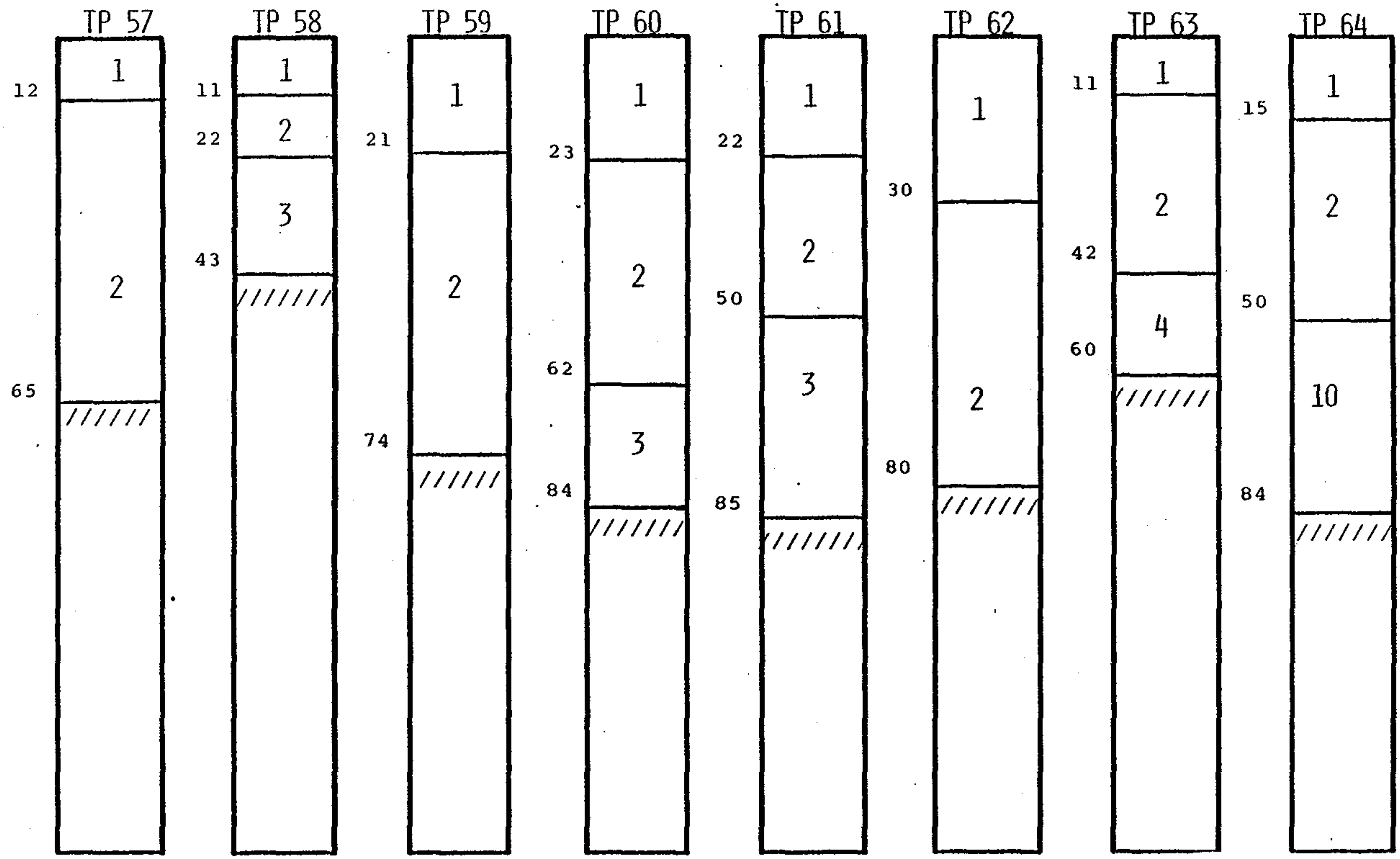
KEY: 1 Topsoil
2 Yellow-brown silty sand
3 Yellow-gray silty sand
5 Gray silty sand mixed with humus
7 Dark brown silty sand
8 Brown/tan/black mottled silty sand
9 Wet gray sand with organic material
//// Unexcavated



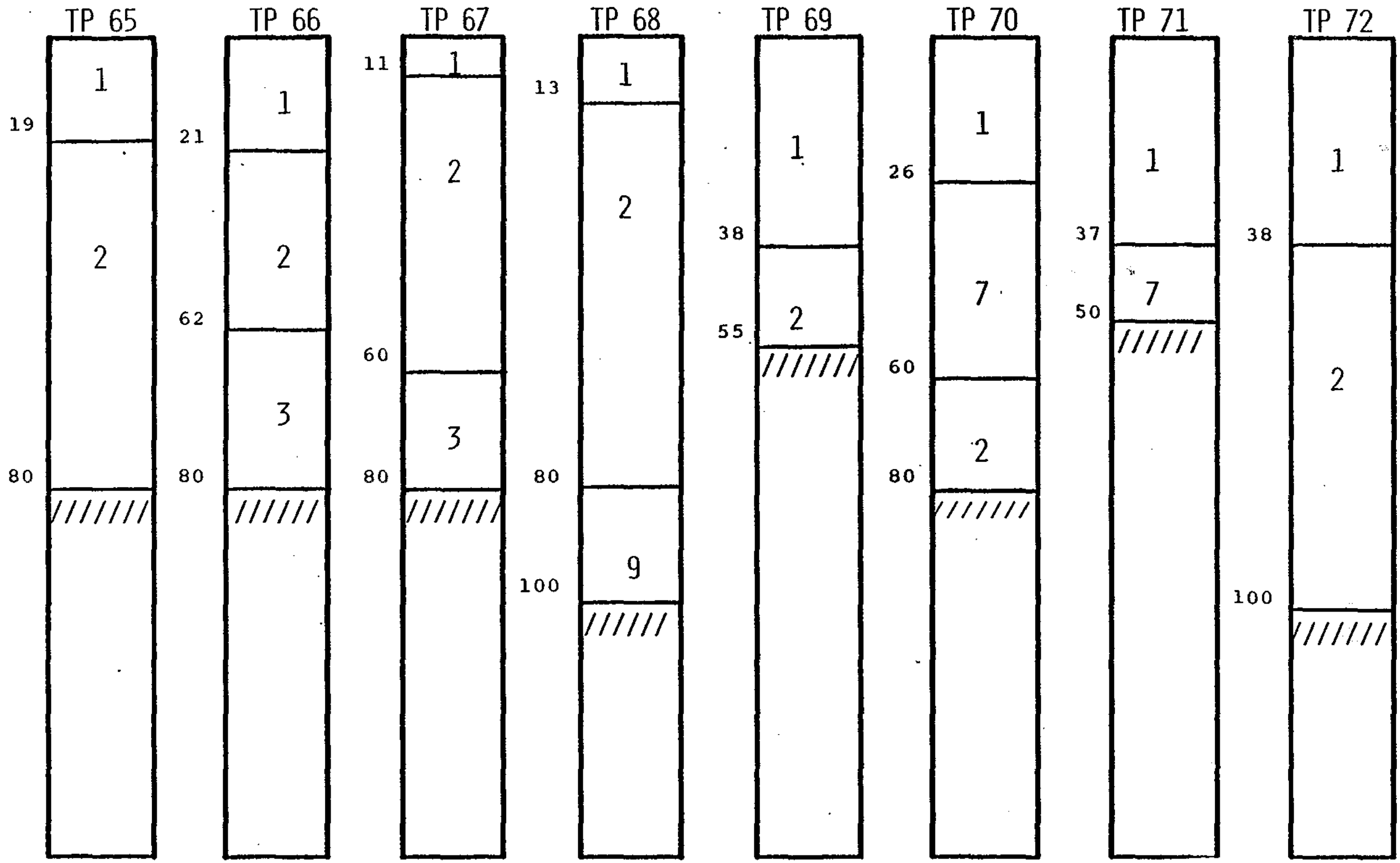
KEY:
1 Topsoil
2 Yellow-brown silty sand
3 Yellow-gray silty sand
6 Gray sand with yellow-orange mottle
10 Tan sand with gray clay mottle
//// Unexcavated



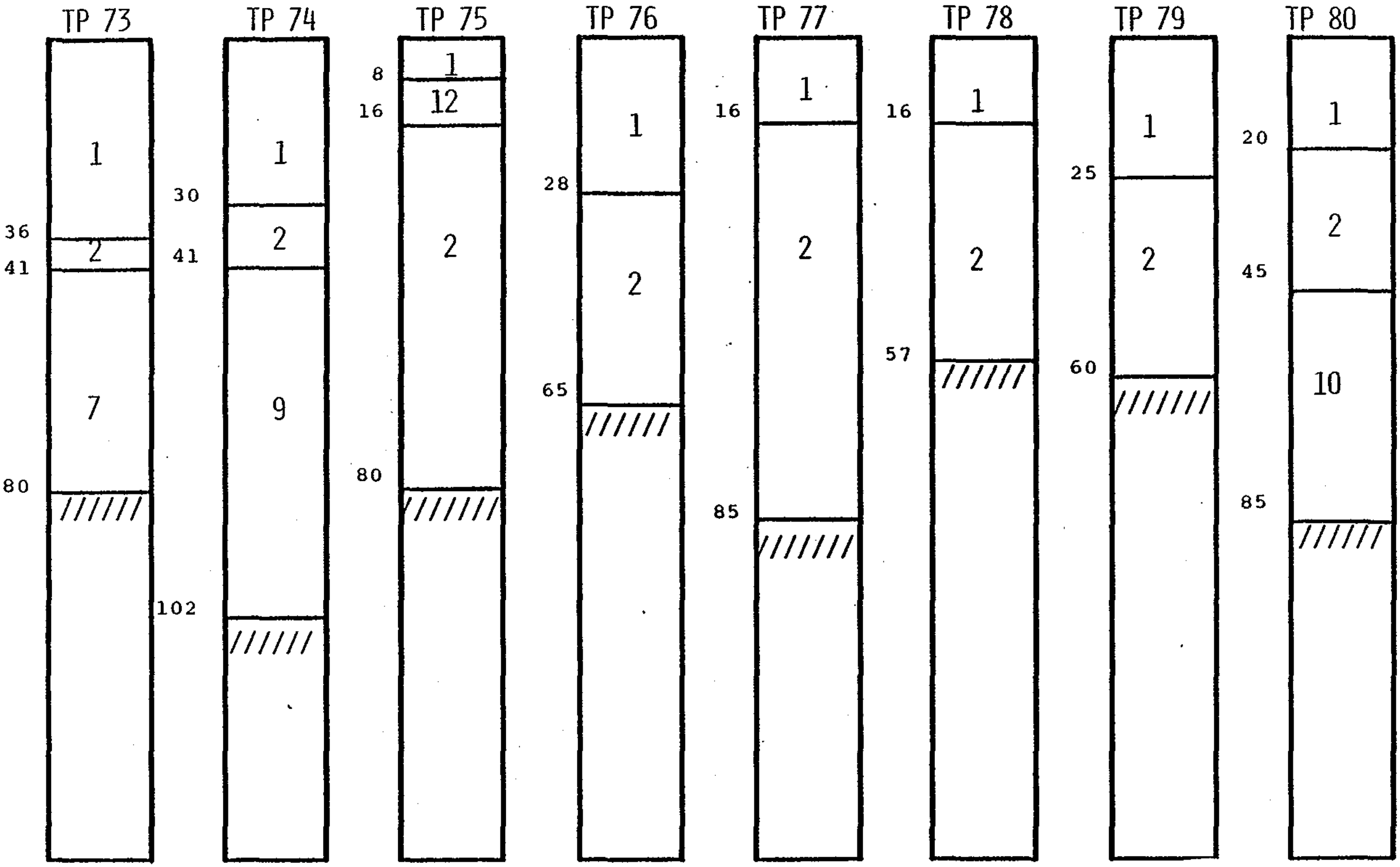
KEY: 1 Topsoil
2 Yellow-brown silty sand
6 Gray sand with yellow-orange mottle
7 Dark brown silty sand
8 Brown/tan/black mottled silty sand
10 Tan sand with gray clay mottle
11 Tan silt
/// Unexcavated



KEY: 1 Topsoil
2 Yellow-brown silty sand
3 Yellow-gray silty sand
4 Gray sandy clay
10 Tan sand with gray clay mottle
/// Unexcavated



KEY: 1 Topsoil
2 Yellow-brown silty sand
3 Yellow-gray silty sand
7 Dark brown silty sand
9 Wet gray sand with organic material
/// Unexcavated



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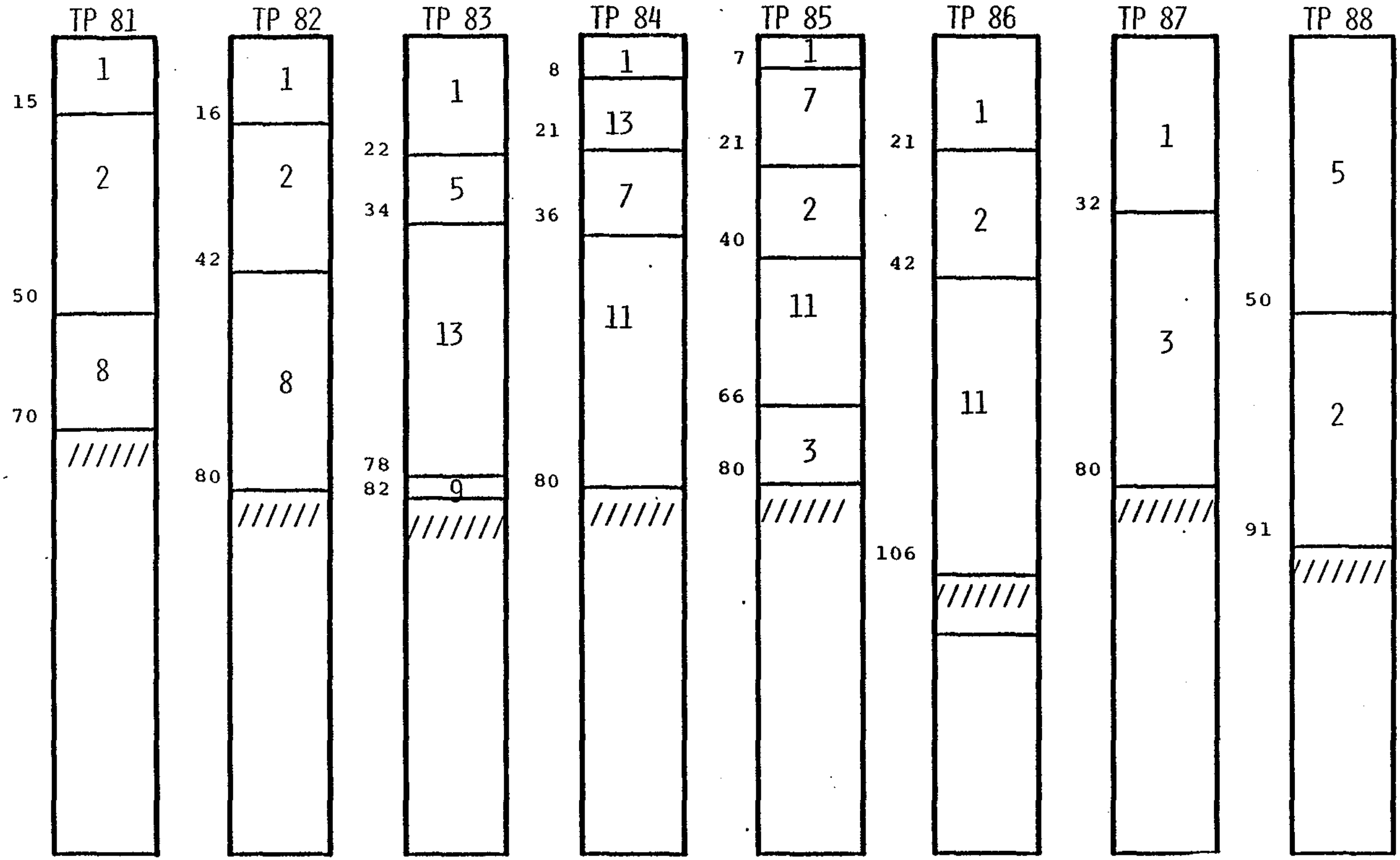
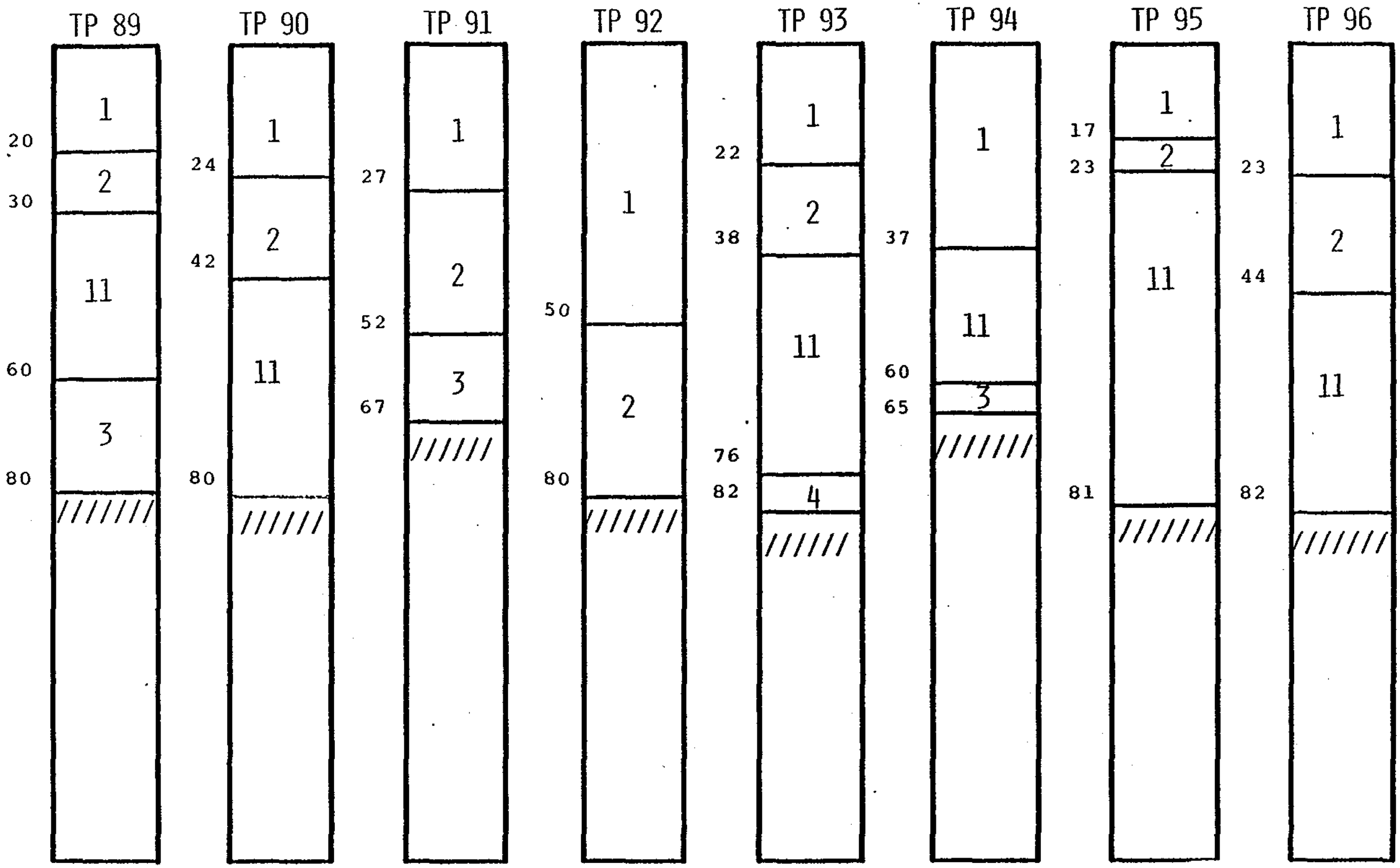
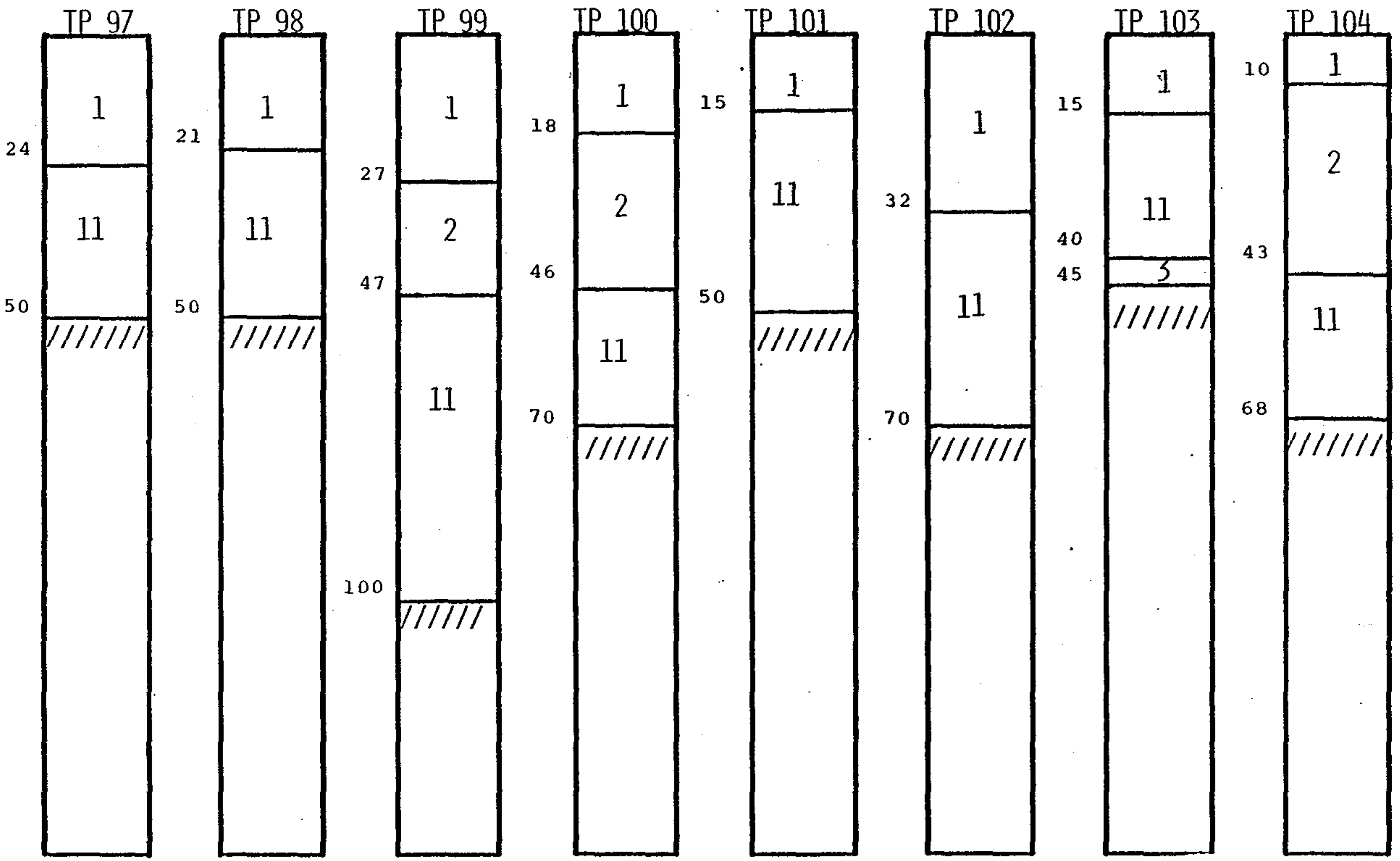
2 Yellow-brown silty sand
7 Dark brown silty sand
9 Wet gray sand with organic material
10 Tan sand with gray clay mottle
12 White sand
/// Unexcavated



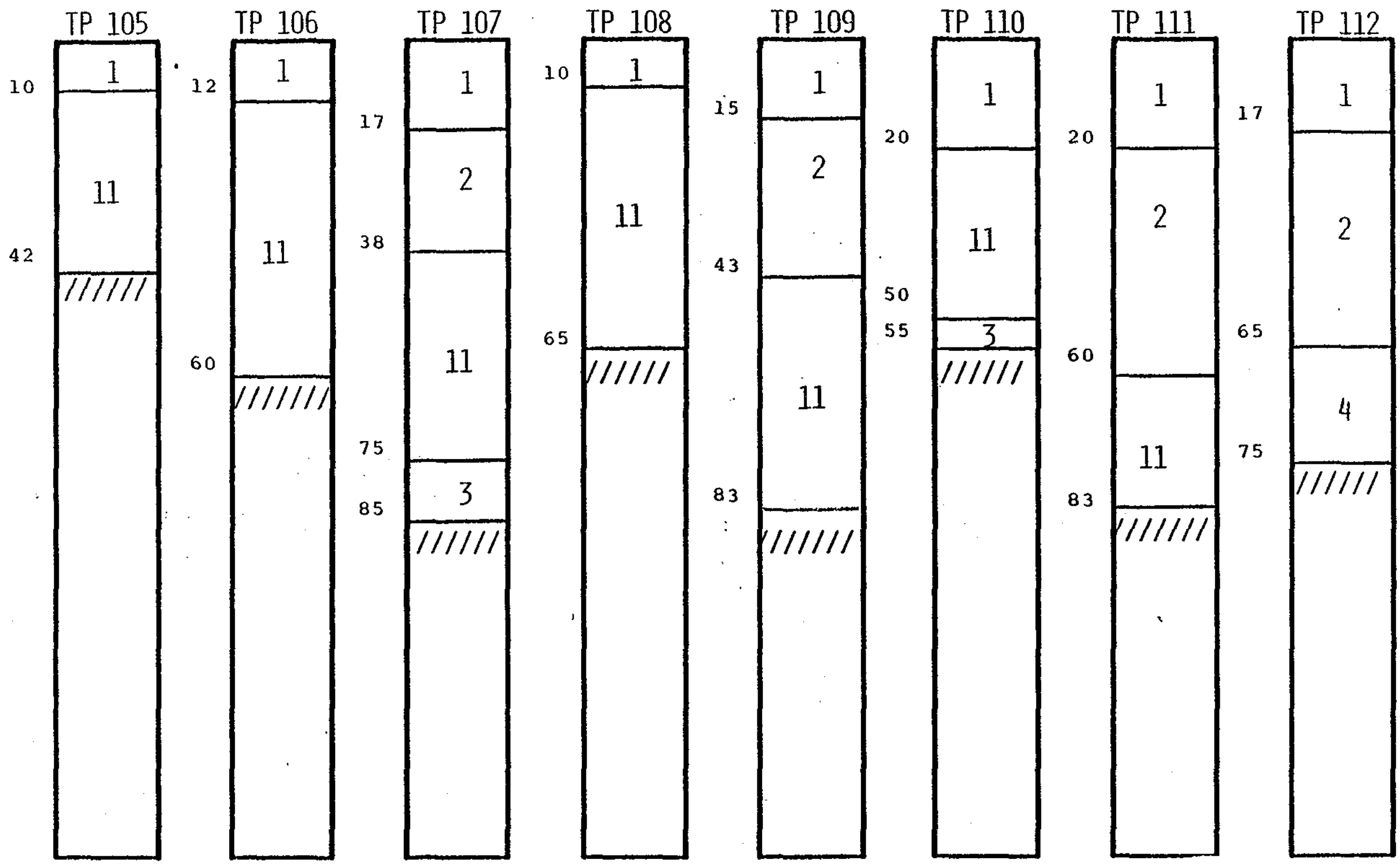
KEY: 1 Topsoil
2 Yellow-brown silty sand
3 Yellow-gray silty sand
5 Gray silty sand mixed with humus
7 Dark brown silty sand
8 Brown/tan/black mottled silty sand
9 Wet gray sand with organic material
11 Tan silt
13 Gray-brown sand with yellow mottle
//// Unexcavated



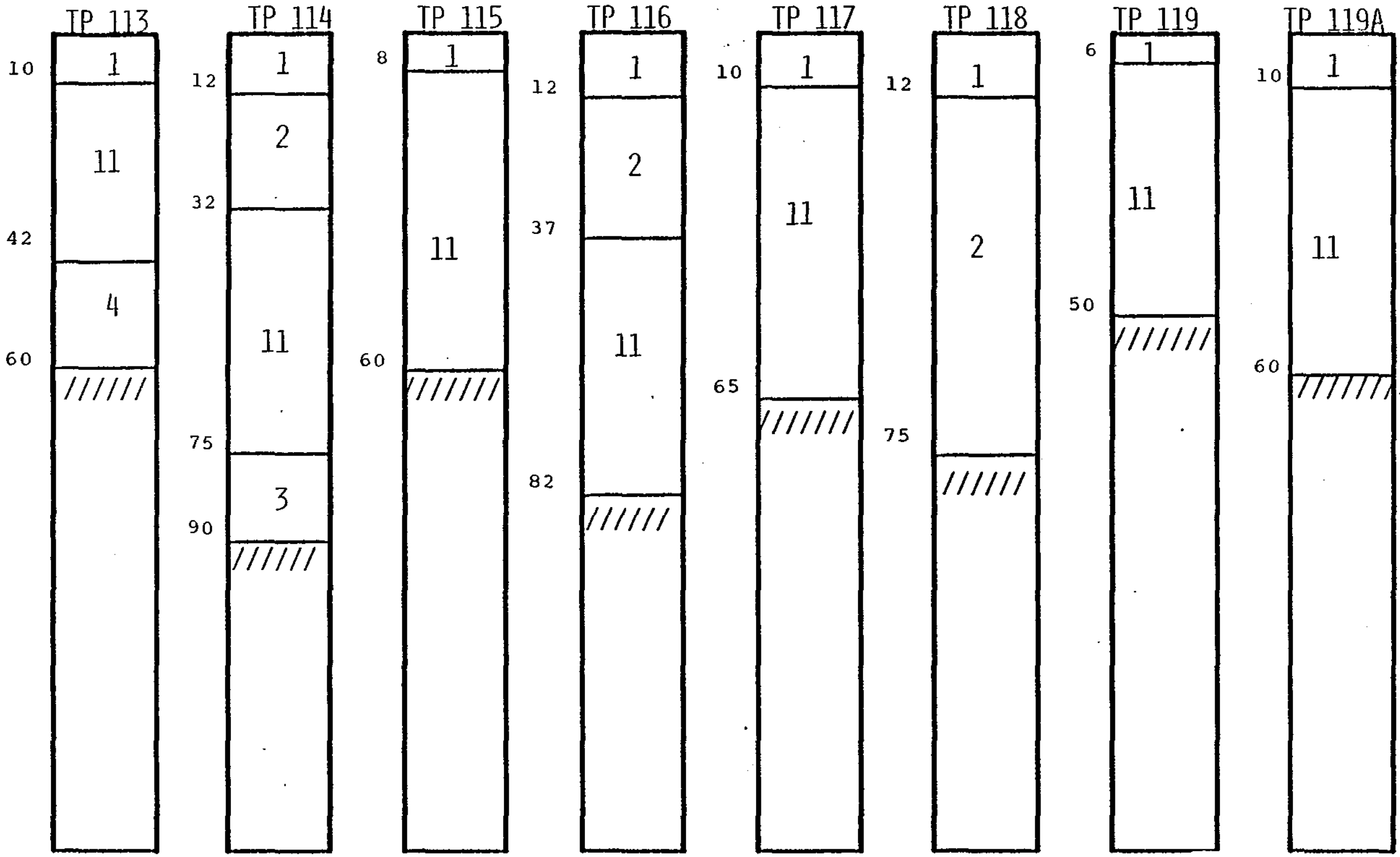
KEY:
1 Topsoil
2 Yellow-brown silty sand
3 Yellow-gray silty sand
4 Gray sandy clay
11 Tan silt
//// Unexcavated



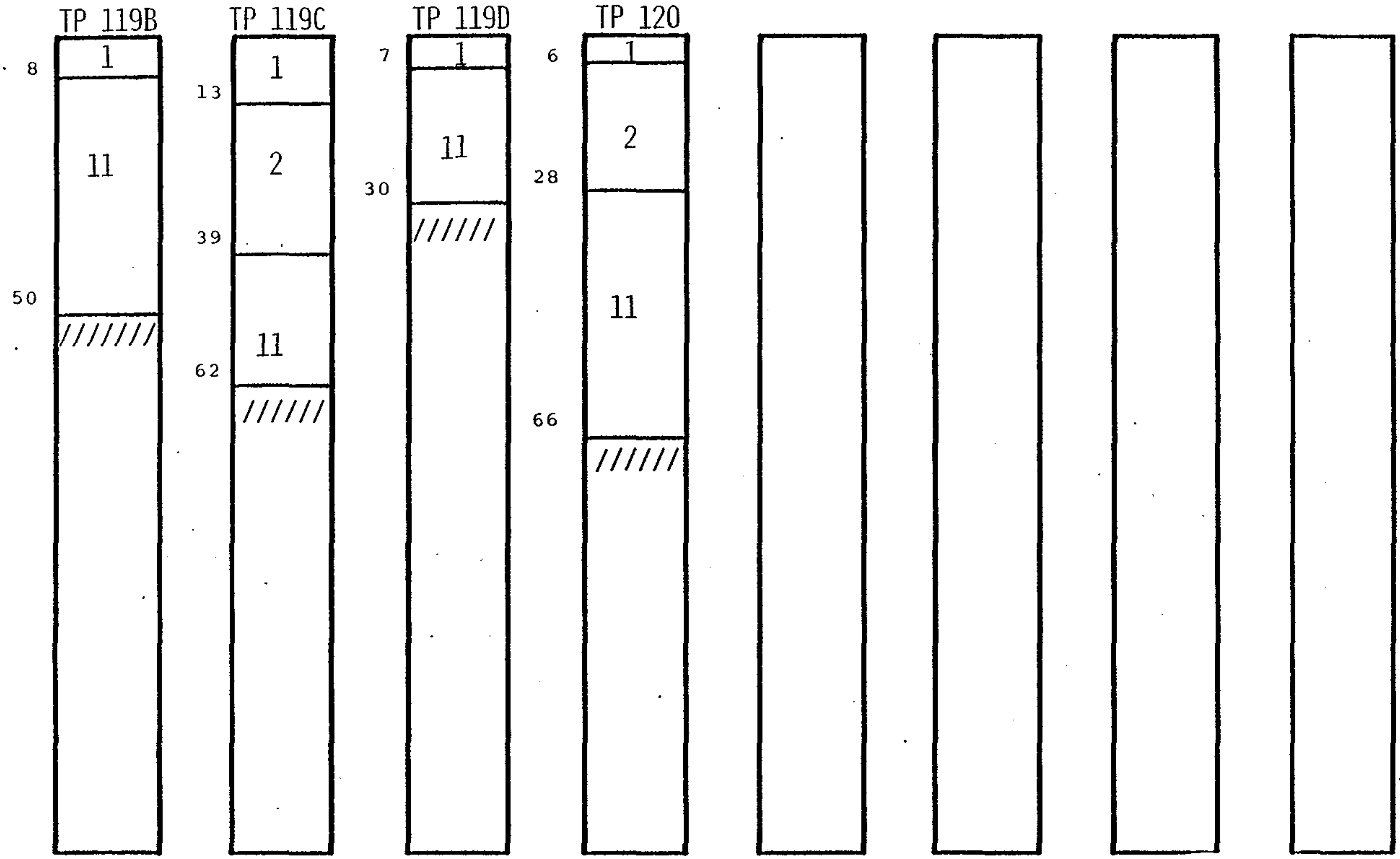
KEY: 1 Topsoil
2 Yellow-brown silty sand
3 Yellow-gray silty sand
11 Tan silt
//// Unexcavated



KEY: 1 Topsoil
2 Yellow-brown silty sand
3 Yellow-gray silty sand
4 Gray sandy clay
11 Tan silt
/// Unexcavated



KEY: 1 Topsoil
2 Yellow-brown silty sand
3 Yellow-gray silty sand
4 Gray sandy clay
11 Tan silt
/// Unexcavated



KEY: 1 Topsoil
2 Yellow-brown silty sand
11 Tan silt
//// Unexcavated

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Maps

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Personal Communication

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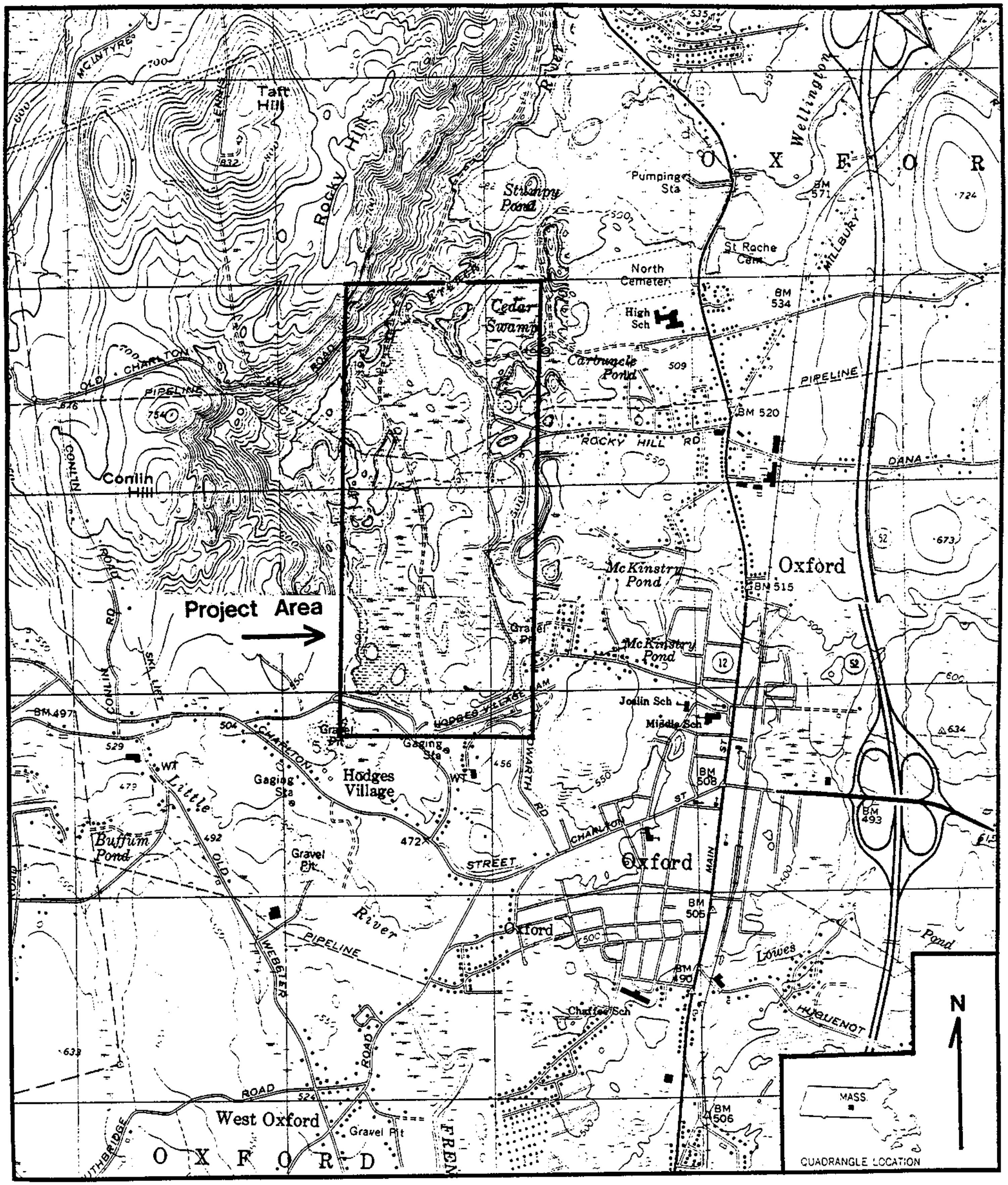


Figure 1. Detail of U.S.G.S. Topographical Maps (Oxford, Mass./ Leicester, Mass./ Webster, Mass.--Conn.), Showing Location of Project Area. Scale: 1:24,000

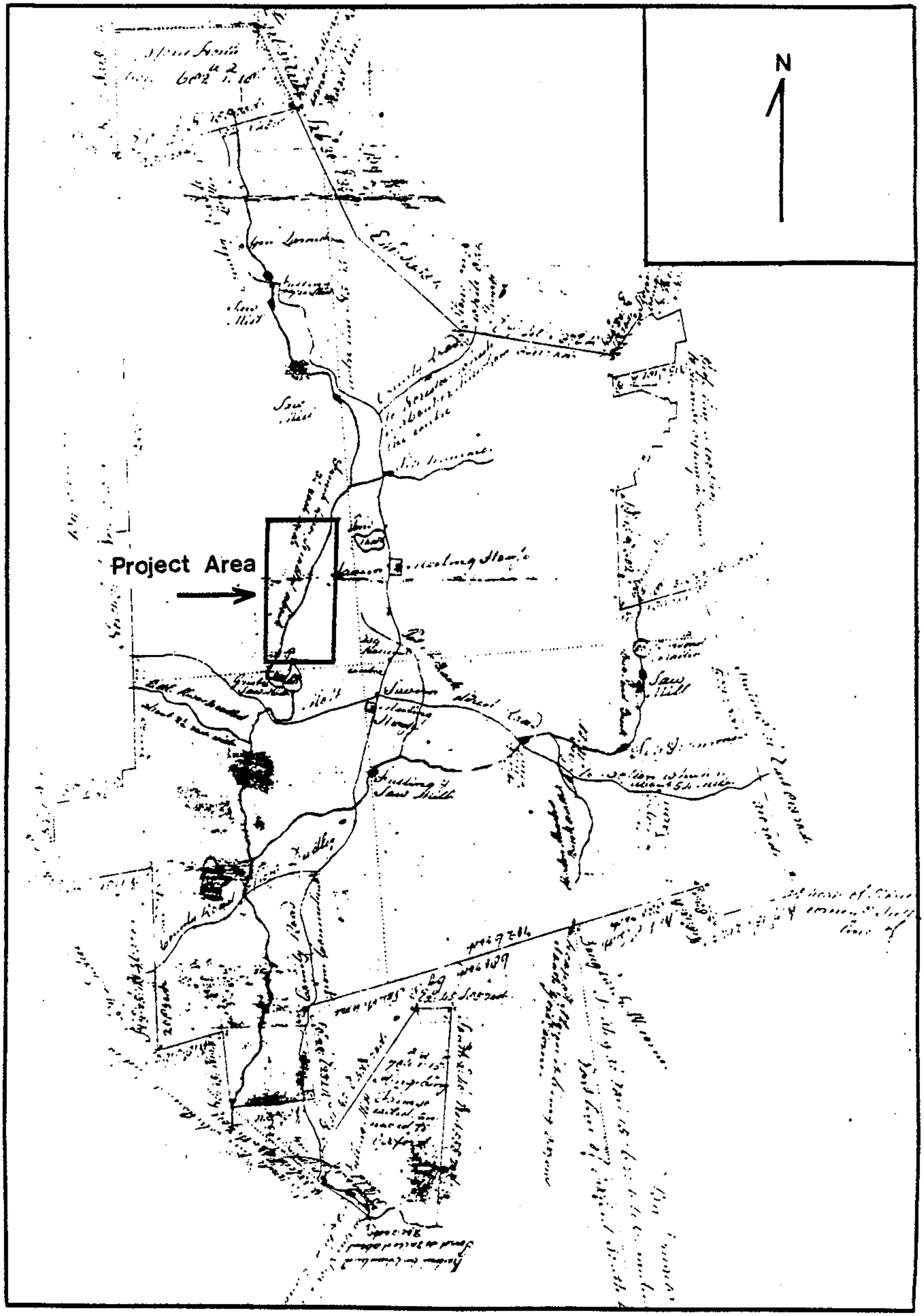


Figure 2. Detail of 1794 Plan of Oxford, Massachusetts (Mass. Archives No. 1274), Showing Location of Project Area. Scale: 1"=4800'

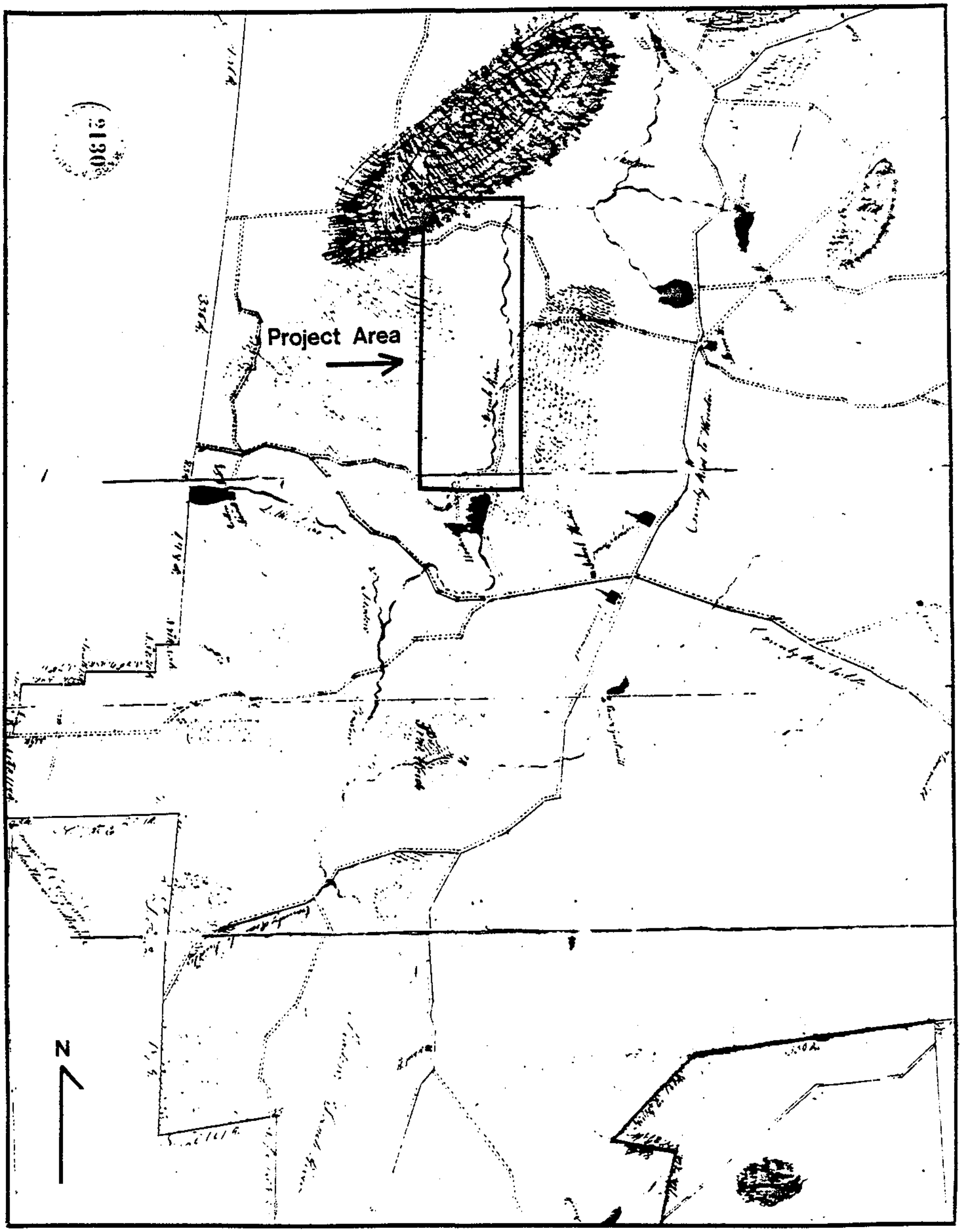


Figure 3. Detail of 1831 Plan of Oxford, Massachusetts (Mass. Archives No. 2130), Showing Location of Project Area. Scale: 1"=2500'

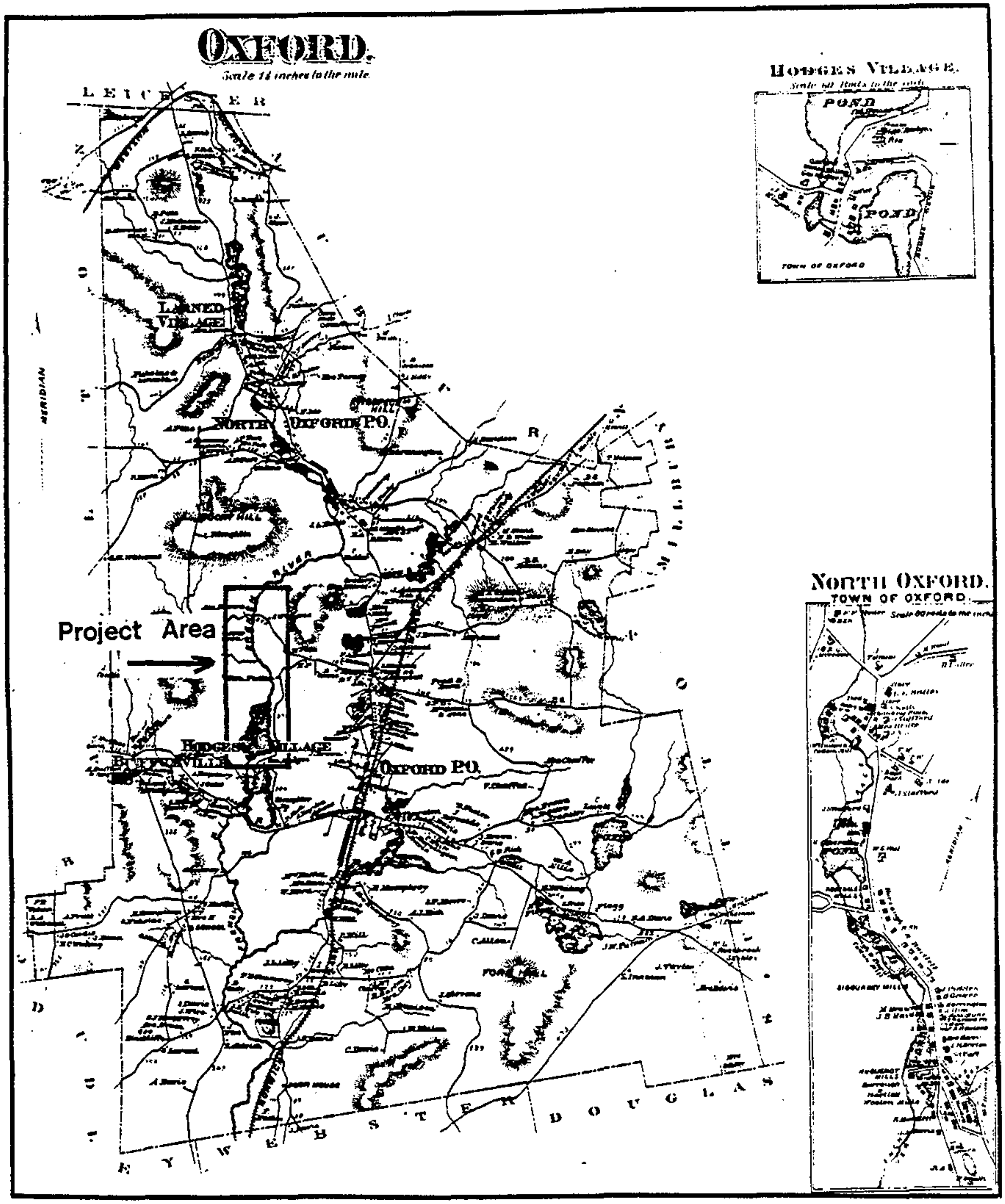


Figure 4. Plan of Oxford, Massachusetts, 1870. F.W. Beers, Atlas of Worcester County, Massachusetts, New York: 1870. Scale: 1"=4400'

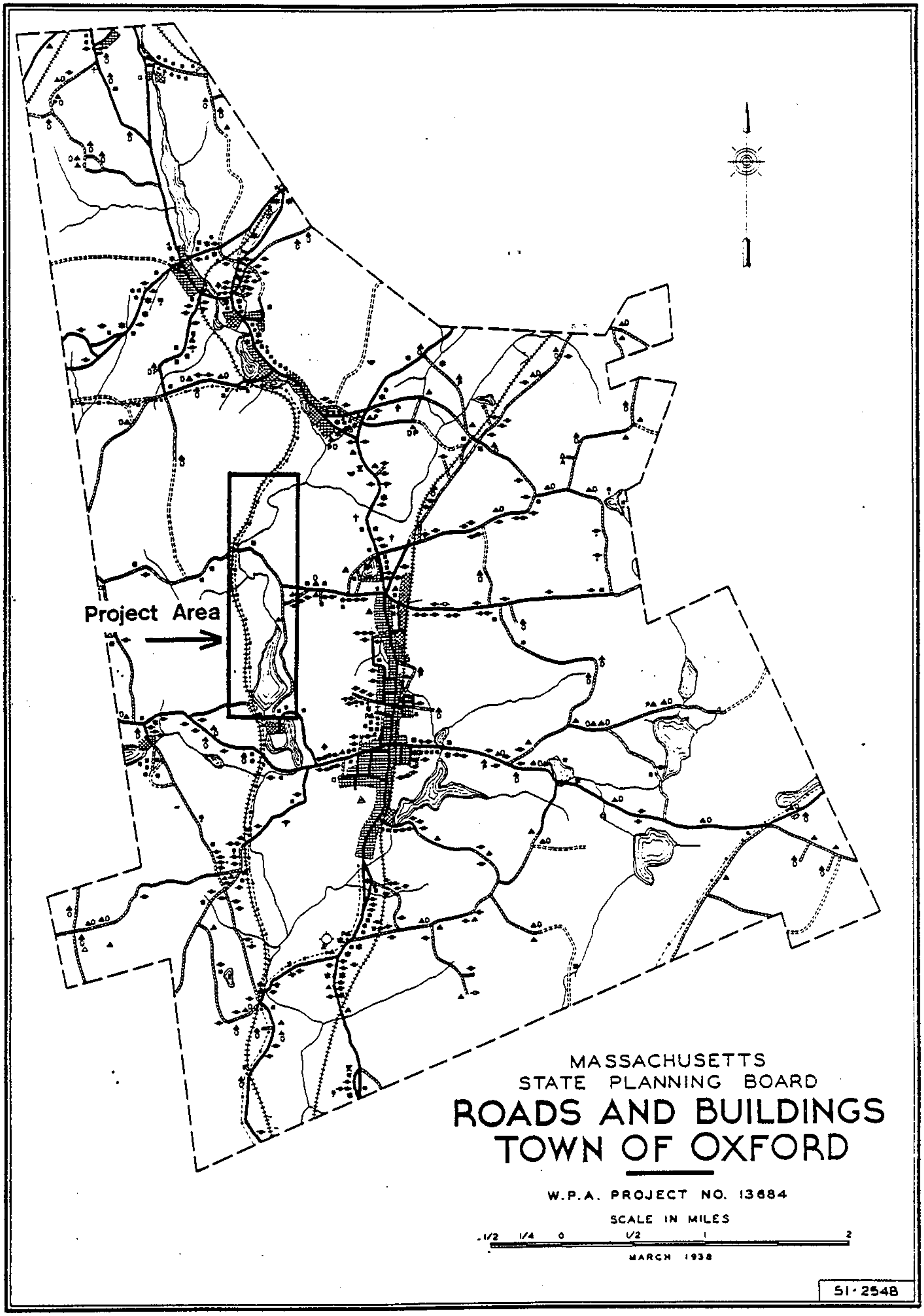
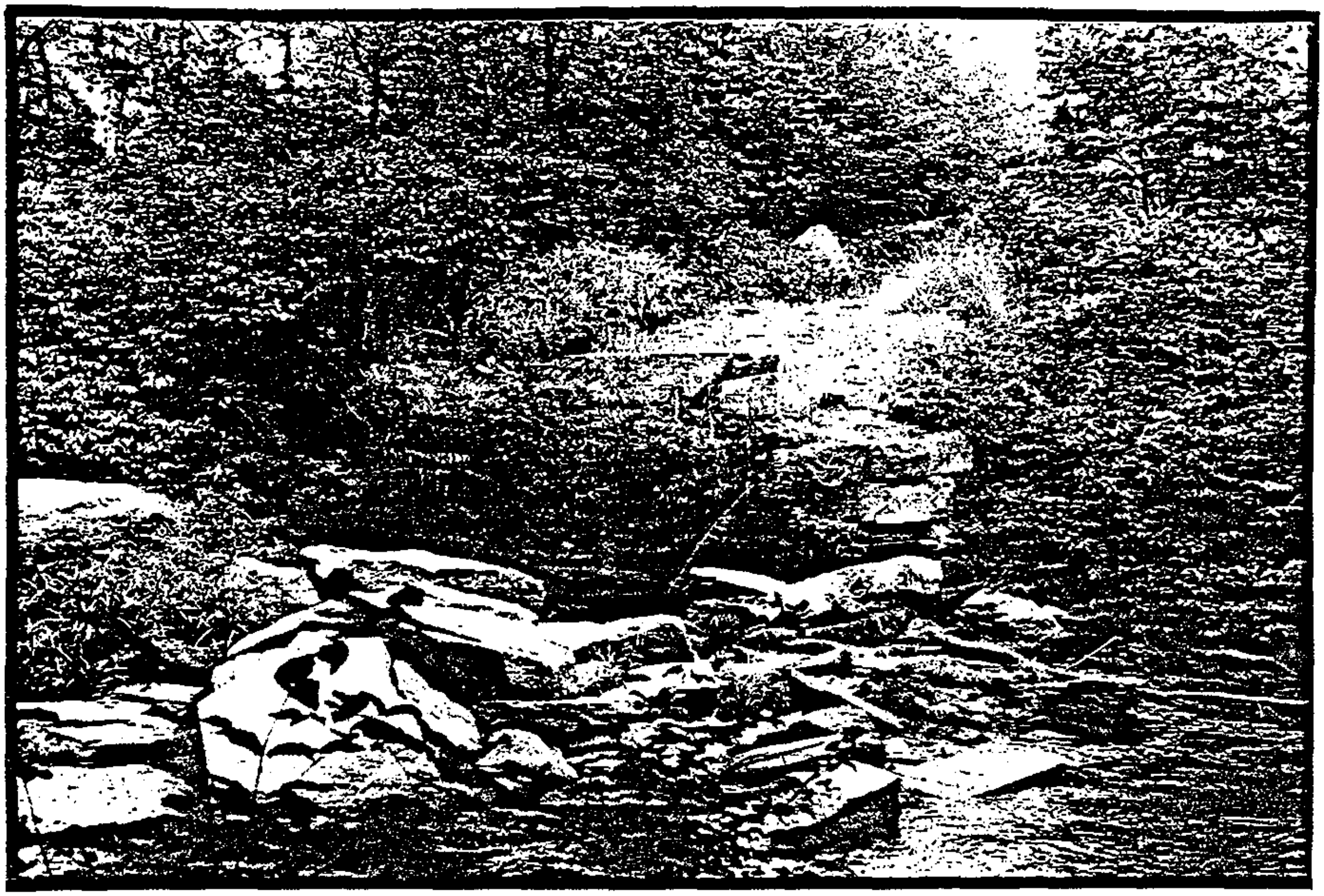

Project Area
MASSACHUSETTS
STATE PLANNING BOARD
ROADS AND BUILDINGS
TOWN OF OXFORD
W.P.A. PROJECT NO. 13684
SCALE IN MILES
1/2 1/4 0 1/2 1 2
MARCH 1938
51-254B

FIGURE 5



View of Old Charlton Road Bridge, Looking West.

FIGURE 6

View of Typical Swampland Within Project Area
(Area 2, Looking East).

FIGURE 7

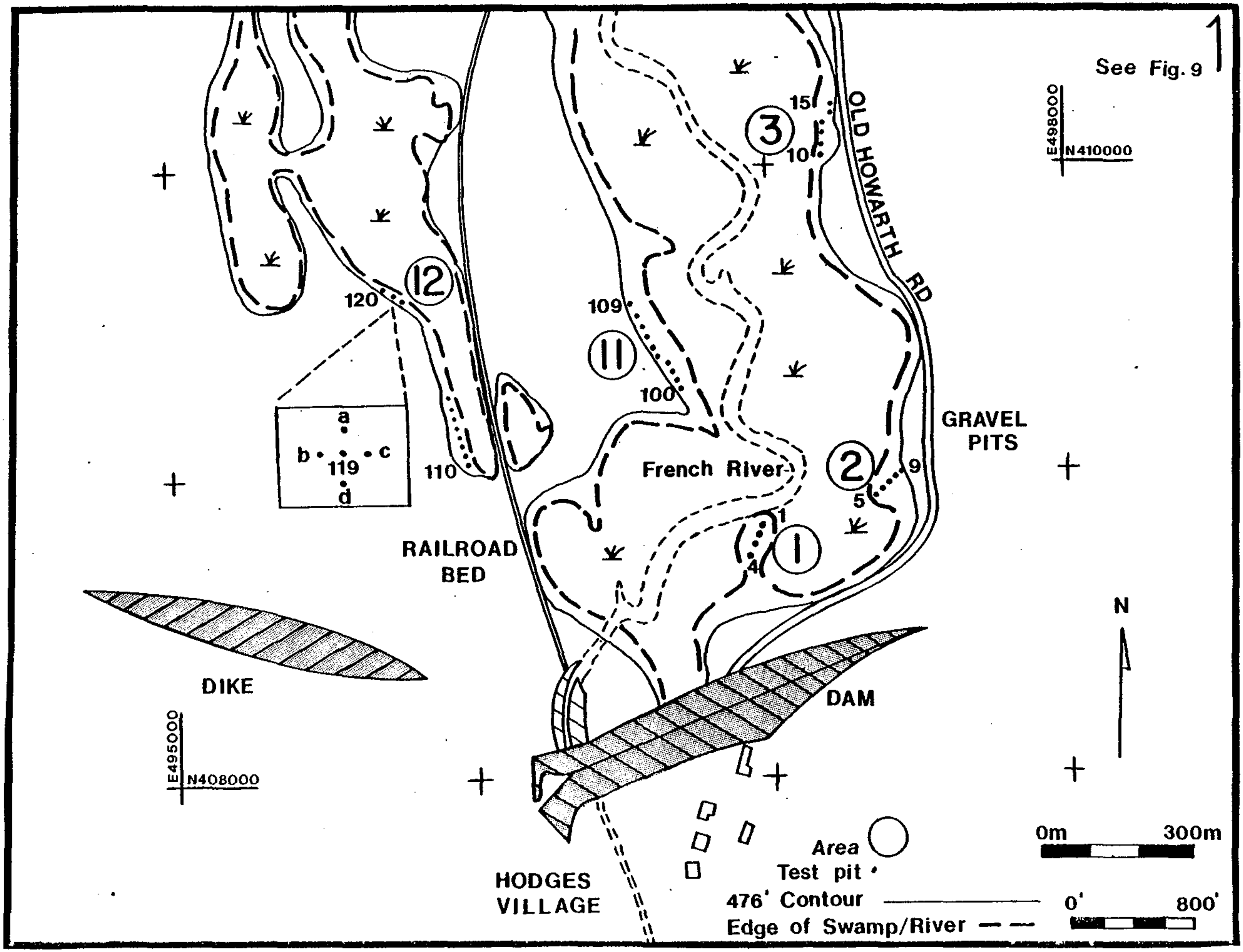


Figure 8. Southern Section of Project Area, Showing Test Pit Locations

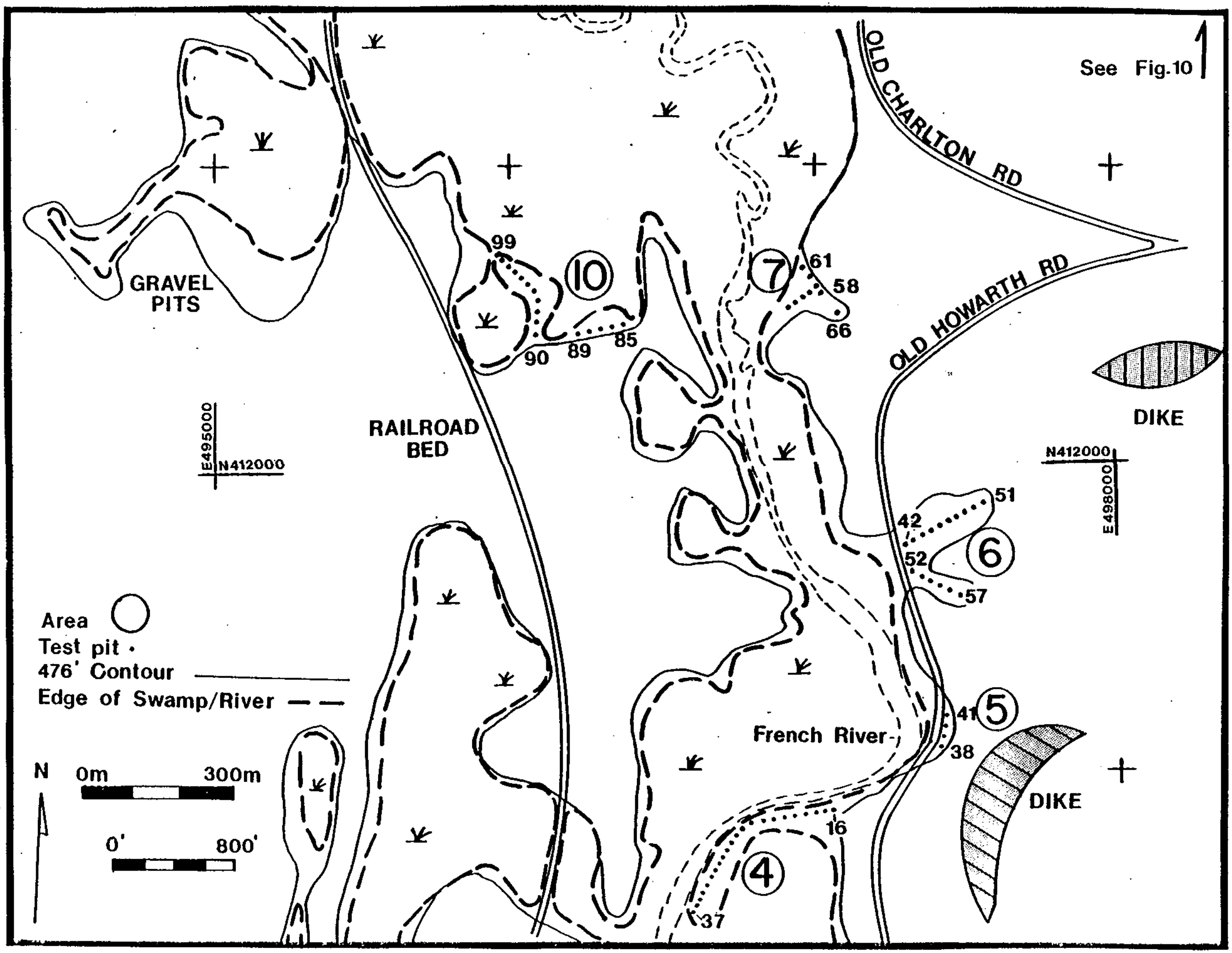


Figure 9. Central Section of Project Area, Showing Test Pit Locations

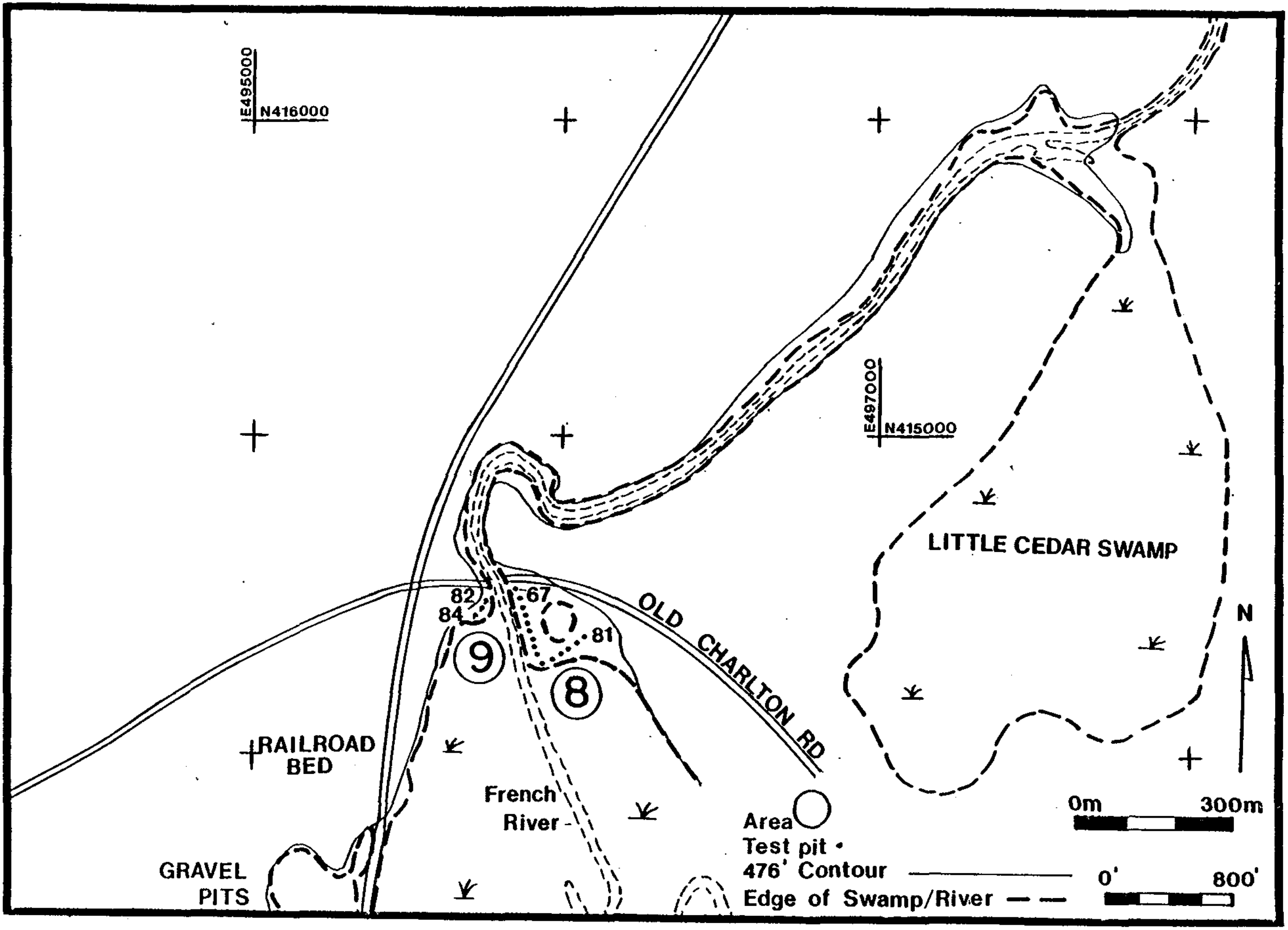


Figure 10. Northern Section of Project Area, Showing Test Pit Locations